Missouri Natural Areas Procedures Manual
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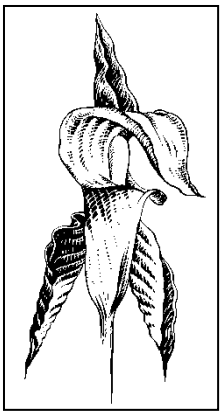
Approved by the Missouri Natural Areas Committee at its meeting on January 27, 2011



Jack-in-the-Pulpit, drawing by Charles W. Schwartz
Logo of the Missouri Natural Areas Program

St. Francois Mountains Natural Area, photograph by David Stonner.

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Preface

Missouri Natural Areas are designated by an interagency committee, the Missouri Natural Areas Committee (MoNAC), with joint approval from the directors of the Missouri Department of Conservation (MDC) and Missouri Department of Natural Resources (MoDNR). Designated Missouri Natural Areas occur on a variety of ownerships, from private individuals to federal land management agencies. The goal of the Missouri Natural Areas Program is to inventory, designate, protect and manage natural areas. Missouri Natural Areas are defined as biological communities or geological sites that represent the natural character, diversity, and ecological processes of Missouri's native landscapes. This is enabled by a memorandum of understanding (MOU) between the signatory organizations comprising MoNAC, including MoDNR, MDC, Mark Twain National Forest (MTNF), Ozark National Scenic Riverways (ONSR), U.S. Fish & Wildlife Service – Ecological Services, Missouri Field Office (USFWS), and The Nature Conservancy – Missouri Chapter (TNC).

Designated natural areas are to be protected and managed indefinitely for the purpose of preserving their ecological integrity and represent the highest and best use of these tracts of lands and waters. Natural areas either retain or have recovered to a substantial degree their ecologic function or have significant floral, faunal, ecological or geological features of scientific, educational, scenic or aesthetic interest in the opinion of MoNAC and other experts. It is the policy of the MoNAC partner organizations to secure for the citizens of Missouri of present and future generations the benefits of an enduring resource of designated state natural areas.

Natural areas are managed for the objectives of: 1) maintaining the ecological integrity of natural communities; 2) providing site appropriate habitat structure and conditions for the continued existence of rare, threatened or endangered species of plants and animals within the context of natural community health; and 3) providing for appropriate and compatible public use and enjoyment. Natural areas are integral to the conservation of Missouri's biological diversity. Active management actions are often required to meet these objectives. Examples of active management might include reinstating historic disturbance processes, such as fire under controlled conditions, or providing for appropriate public use by constructing well-designed hiking trails that minimize recreational impacts.

To better assist natural resources staff, scientists, and the public involved with the inventory, designation, protection, restoration, management and interpretation of designated natural areas, MoNAC has assembled this Missouri Natural Areas Procedures Manual. This manual contains the current MOU codifying the MoNAC, a description of MoNAC's administrative procedures and forms, a set of natural area management guidelines, standard forms, and related appendices.

This manual will always be a work in progress and subject to revision especially as regards the section on management of natural areas. Therefore, the manual will be dated and have a version number referenced to it. Revisions and edits to the manual will require review and approval by MoNAC resulting in the manual having a new date stamp and version number. Changes to the manual require approval from MoNAC (chairperson's signature) but does not require signature approvals from all the partner organization's heads as is needed for the MOU.

A Brief History of the Missouri Natural Areas Program

Missouri's natural areas program had its roots in the early work of Bill Crawford with the Missouri Department of Conservation (Thom 2005). Crawford promoted the concept of a natural areas program to MDC director Bill Towell in 1966. Other MDC staff supportive of a natural areas program during

that time included John Wylie, Charlie Schwartz, and MDC assistant director Allen Brohn. Dr. Bill Elder at the University of Missouri-Columbia at that time had already begun working with his graduate students to locate natural areas in Missouri.

Carl Noren became MDC director in 1967 and asked Brohn to chair a committee to form a natural areas program. In 1970, the Conservation Commission created the Missouri Natural Areas System, and in 1971, the first set of Missouri Natural Areas were designated on lands owned or managed by MDC. By 1976, just before the passage of the conservation sales tax, there were 45 Missouri Natural Areas on lands owned by MDC, the L-A-D Foundation, and The Nature Conservancy.

In 1976, a National Science Foundation grant supported the "Natural Areas System for Missouri State Parks" study on Missouri Department of Natural Resources lands. Widespread interest by a number of organizations including The Nature Conservancy, the L-A-D Foundation, the Missouri Prairie Foundation, the Society of American Foresters, the Missouri Natural Areas Survey, the University of Missouri and others resulted in the formation of the Missouri Natural Areas Advisory Group. This group included many notable persons who contributed greatly to the preservation of natural areas in Missouri and outside of the state. These two initiatives were the catalyst for the next step that was taken on April 20, 1977. On that date the Missouri Department of Natural Resources and the Missouri Department of Conservation signed a joint agreement initiating a statewide Missouri Natural Areas Program and organized the Missouri Natural Areas Committee. In 1989, the Mark Twain National Forest and the Ozark National Scenic Riverways became voting members of MoNAC. In 2003, the Missouri field office of the U.S. Fish & Wildlife Service and the Missouri Chapter of The Nature Conservancy became voting members of MoNAC. Today Missouri Natural Areas occur on lands owned by MDC, MoDNR, MTNF, ONSR, TNC, L-A-D Foundation, U.S. Army Corps of Engineers, Missouri Prairie Foundation, University of Missouri-Columbia, Southeast Missouri State University, municipalities, private landowner associations, and private individuals. There were 180 Missouri Natural Areas encompassing 70,758 acres in January 2010.

Missouri Natural Areas Committee Memorandum of Understanding

The coordination of a Missouri Natural Areas Program is formalized in an MOU between the partner organizations (MDC, MoDNR, MTNF, ONSR, USFWS, and TNC). This MOU states the duties, authority, and responsibilities of the Missouri Natural Areas Committee. This MOU is the principal instrument in creating the Missouri's Natural Areas System. Please see Appendix A for the current version of the MOU.

Key authorities of MoNAC via the MOU are:

- Recommend areas for natural area designation to the directors of MDC and MoDNR and the administering entity of the site.
- Recommend delisting of natural areas for cause to the directors of MDC and MoDNR and the administering entity of the site.
- Maintain an official registry of designated Missouri Natural Areas.
- Recommend general management guidelines for natural areas and review and comment on management plans for natural areas.

Missouri Natural Areas Committee Administrative Procedures

MoNAC chairmanship rotates every three years between a MoDNR and MDC representative. The vice-chair is always from the other state agency (i.e., if the chair is from MoDNR then the vice-chair is from MDC). MoNAC designates from its MoDNR or MDC members the person to serve as chair and vice-chair. The chairing agency coordinates activities of MoNAC for its term and serves as the spokesperson for the committee. MDC and MoDNR each have four voting members on MoNAC with MTNF, ONSR, USFWS, and TNC having one voting member each. MDC and MoDNR each designate a staff person to serve in the role as natural areas coordinator for their agencies and provide staff support to MoNAC. MDC houses the official registry of Missouri Natural Areas.

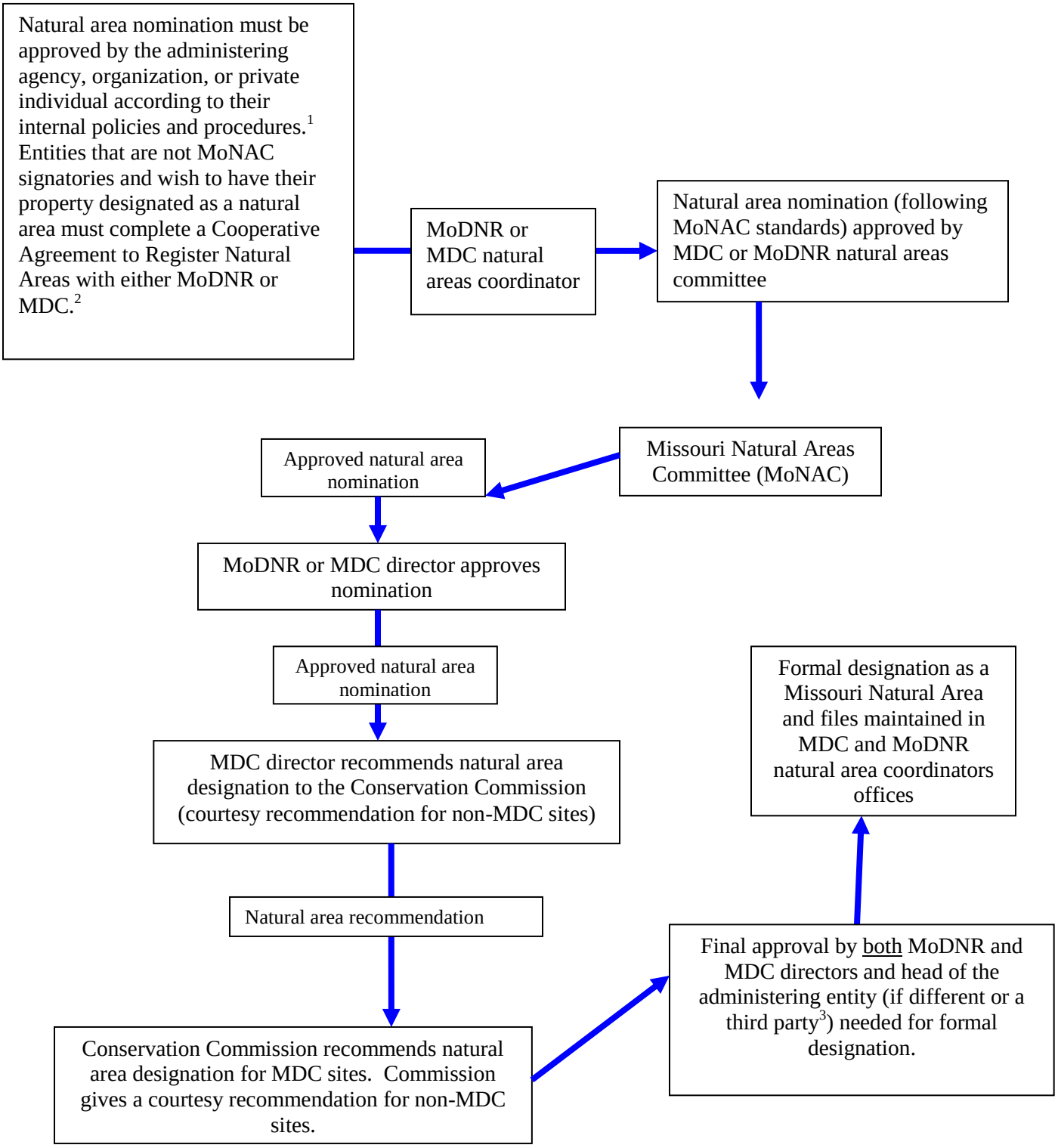
MoNAC meetings are typically held quarterly and minutes recorded. Meeting minutes are circulated among MoNAC staff for comment and official minutes are approved at the next meeting. MoNAC meeting minutes are archived at MDC. The MoNAC chair facilitates the meeting and Robert's Rules of Order are generally followed for conducting meetings. To be approved, a measure before MoNAC will require a majority of the votes cast at a meeting. Natural area nominations and delisting reports should be sent to committee members 30 days in advance of the meeting in which they will be discussed. However, this requirement may be waived upon approval by the committee. Requests to delist a natural area need to be heard at two separate MoNAC meetings. Additions to natural areas follow the same process as with first-time nominations but an abbreviated form is used. With natural area additions, if the addition substantially changes the original natural area management recommendations, then an update to the original natural area management recommendations should be done in tandem with the natural area addition nomination for MoNAC approval. The mechanics of natural area nominations and delistings are detailed in Figures 1 and 2 below and forms are found in the last section of this manual, prior to the References.

Natural area nominations and delisting reports should follow standard forms agreed upon by MoNAC. Nominations and delisting reports will be reviewed and approved by either the MDC or MoDNR internal natural areas committees and the area will be inspected by a representative of either of these committees before MoNAC review. Natural area nominations will include a management recommendations section. These natural area management recommendations are considered a management plan or set of management objectives for the natural area once formally designated. Nominations of natural areas may be prepared by the owner or by someone else at the owner's request. The owner of a candidate natural area must be aware of the area's nomination and must be willing to consider the area's registration before MoNAC will consider the nomination. All natural area nominations and delisting requests are presented before the Missouri Conservation Commission for recommendation as has been the historic precedence (although this is not a requirement for designation of areas not owned and managed by the Department of Conservation.).

Non-controversial business items may be discussed and voted on by MoNAC via electronic mail (email). This process affords 30 days for review (with the option of a waiver of this requirement) and an email vote on items brought to the chairperson's attention as an email voting item. Any MoNAC member can request that the issue be brought back to committee for further discussion if deemed necessary. The results of the email vote are reported at the next in person MoNAC meeting, approved, and entered into the official minutes.

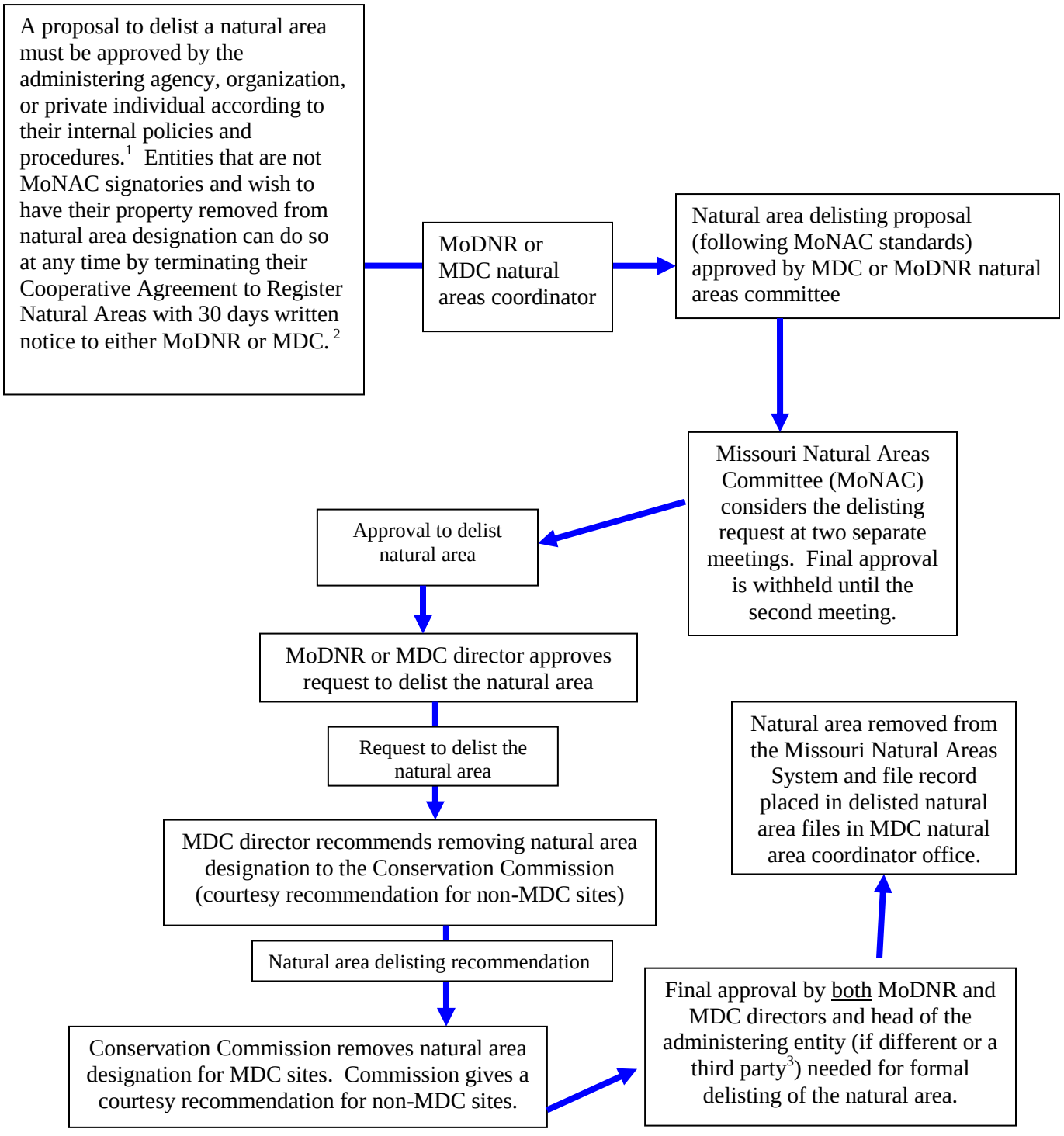
Natural areas designated on land ownerships that are non-signatory to the MOU need a Cooperative Registry Agreement with either MoDNR or MDC that is approved by either agency's General Counsel and Director. If ownership changes, the Cooperative Agreement is voided, and the natural area is by

Figure 1: Natural Area Designation Process



[1] For example, on Mark Twain National Forest lands, natural area designation typically requires National Environmental Policy Act coordination and possibly an amendment to the Forest Plan.
[2] Privately owned lands require a Cooperative Agreement to Register Natural Areas that is approved by the director of either MDC or MoDNR and their legal counsel.
[3] Some natural areas may have multiple ownerships in which case the head of each entity needs to sign off on the approval form. For example, a natural area with ownership of MDC and the ONSR requires signatures from the superintendent of the ONSR as well as the directors of MoDNR and MDC.

Figure 2: Natural Area Delisting Process



[1] For example, on Mark Twain National Forest lands, removing a natural area from the Missouri Natural Areas System would likely require National Environmental Policy Act coordination and possibly an amendment to the Forest Plan.
[2] If a privately owned natural area is sold or transferred to another owner, the natural area is automatically removed from designation as the Cooperative Agreement to Register Natural Areas is automatically voided upon the ownership change.
[3] Some natural areas may have multiple ownerships in which case the head of each entity needs to sign off on the MoNAC approval to remove designation form. For example, a natural area with ownership of MDC and the ONSR requires signatures from the superintendent of the ONSR as well as the directors of MoDNR and MDC.

default delisted. However, if the new owner wishes to reinstate a Cooperative Agreement, then it is the procedure that unless substantial changes have occurred to the natural area based upon a field visit from either the MoDNR or MDC natural areas coordinator, or the natural area management recommendations need to be significantly altered, then the delisted natural area is brought back into the system via a new Cooperative Agreement and MoNAC approval without the need for a formal nomination process.

Missouri Natural Area Management Guidelines

Introduction

These natural area management guidelines developed by MoNAC are intended to explain the general rationale for managing natural communities, clarify the rationale for directing appropriate public uses, and guide natural area design and management with the goal of Missouri Natural Areas perpetually sustaining their valuable resources. Note that flexibility has been built into these guidelines to provide natural area managers the ability to address unique management opportunities or site-specific conditions for which these guidelines may not be totally relevant. Missouri Natural Areas often constitute a portion of larger conservation lands such as state parks and historic sites, conservation areas, national forests, national parks, national wildlife refuges, municipal parks, and privately owned properties. Such lands often have outdoor recreation (including hunting and fishing) and or commodity production as primary management objectives; thus, they usually have a broader set of compatible uses than is appropriate for designated Missouri Natural Areas.

MoNAC is comprised of a variety of organizations. Each of these organizations possesses different mission statements, enabling policies, rules, and procedures. These guiding principles influence the types of management practices and public uses appropriate on designated Missouri Natural Areas depending on the MoNAC organization that owns a particular natural area. Furthermore, designated natural areas owned by non-MoNAC members, including private landowners, other public entities, and non-government organizations, also have their own set of rules that influence natural area management practices and public use. While these guidelines are written to be broad in terms of allowable management practices and public uses, the primary purpose for which a natural area is designated is the highest management priority. The range of natural area management practices for specific natural areas can be more restrictive based upon the recommendation or policy of the natural area landowner.

MoNAC has the authority to designate and remove from designation Missouri Natural Areas. MoNAC does not have the authority to dictate to agencies and entities how to specifically manage their designated natural areas. MoNAC has the authority to recommend management guidelines and plans. If a management action is taken that causes deleterious irreversible harm to the ecological integrity of a natural area, MoNAC has the authority to recommend removal of the site from the Missouri Natural Areas System.

MoNAC was originally chartered in April 1977. Since then, the science of conservation biology and natural areas management has evolved such that many earlier natural area designations contain outdated management recommendations. Over the past 30 years, a huge tide of increasing populations of non-native, invasive species (NNIS) and an increasing pace of land development and degradation has made the original passive management approach of many natural area management recommendations too simplified in terms of sustaining the ecological integrity of the sites they intended to conserve. Natural area managers and planners working off of natural area management recommendations predating 1990 should carefully read through the recommendations and consider the need to revise these with MoNAC

guidance. In general, natural area management recommendations since 1990 have incorporated management practices more in line with the current science of conservation biology.

Management of natural areas should strive to be consistent with the officially accepted management recommendations contained in the final natural area designation document and the guidance herein. When in doubt, natural area managers should ask their MoNAC representative(s) for guidance.

These recommended natural area management practices will always be to some extent "a work in progress" as the science and practical knowledge of natural community management develops. MoNAC recognizes that natural areas should be managed within an adaptive management framework. These recommendations are not final and site-specific analysis and novel issues will always constrain the development of a comprehensive set of natural area management practices. Field staff and researchers' input will always be instrumental in compiling and revising acceptable natural area management practices. Last, MoNAC wishes to thank the tireless work of natural area managers, researchers, and the interested public who make the conservation and protection of our Missouri Natural Areas System a reality.

Goals of the Missouri Natural Areas Program

Natural areas are defined as biological communities or geological sites that preserve and are managed to perpetuate the natural character, diversity, and ecological processes of Missouri's native landscapes. They are to be protected or managed for the purpose of preserving their natural qualities.

Therefore, the Missouri Natural Areas Program, through the designation of Missouri Natural Areas, seeks to:

1. Represent significant examples of natural communities and their respective ranges of variability;
2. Maintain viable populations of all native species in natural patterns of abundance, interaction, and distribution;
3. Maintain ecological and evolutionary processes including disturbance and flow regimes, nutrient cycles and biotic interactions; and
4. Provide the public with opportunities for appropriate outdoor recreation, environmental education and interpretation, aesthetic enjoyment, and scientific study.

Desired Conditions for Natural Communities

Natural areas should be nominated for natural communities that best exhibit qualities and disturbance regimes as they likely occurred prior to European settlement (Nelson 2010). Because modern settlement has altered nearly every acre of Missouri's landscape, natural areas are those lands and waters that have been least altered over the past 200 years. Natural areas should have a high degree of ecological (biological) integrity as defined by Angermeier and Karr (1994) as "…the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region." Desired conditions for natural communities found on natural areas are detailed below.

Terrestrial natural communities should:

- Reflect natural levels of native species diversity appropriate for the type of community, especially species that are considered conservative (indicative of high biotic integrity), remnant-dependent, or characteristic.
- Be dominated by native plants and animals and not non-native species.
- Have unplowed, minimally eroded soils.
- Be dominated by native perennial vegetation.
- Have a range of vegetation structures and age classes.
- Have restorable disturbance regimes, e.g., fire or flooding.

Cave natural communities should:

- Reflect natural levels of native species diversity, including troglobites, appropriate for the type of community.
- Have minimal water quality impairment issues.
- Be rich in geological formations and or microhabitats (e.g., drip pools).
- Have minimal current human disturbances.

Aquatic natural communities should:

- Reflect natural levels of native species diversity appropriate for the type of community, especially species considered indicative of high biotic integrity.
- Have minimal water quality impairment issues.
- Have natural flow regimes or flow regimes that are minimally altered by impoundments, water withdrawals, etc.
- Be dominated by native animal species.
- Have natural stream channel meanders and habitat diversity.
- Have adequate riparian buffer vegetation with unrestricted stream-floodplain connectivity.
- Have watersheds dominated by preferably native vegetative cover with minimal impervious surfaces (e.g., roads, buildings) and row crop agriculture.

Guiding Principles of Natural Area Design

Natural areas should:

- *Represent to the degree practical, the best remaining examples of Missouri's terrestrial and aquatic natural communities and natural geologic features as defined in Nelson (2010), Pflieger (1989), and Hebrank (1989), respectively.* Definitions and descriptions of high-quality terrestrial natural communities are found in Nelson (2010). High-quality aquatic natural communities are as defined in Pflieger (1989) but not to the same degree of detail as for terrestrial natural communities. So, additional information on fish species (Pflieger 1997, Doisy et al. 2008), crayfish species (Pflieger 1996), mussels (Oesch 1995, McMurray 2008), and benthic macroinvertebrates (Rabeni et al. 1997, Sarver et al. 2002) indicative of high-quality waters should be used to define a high-quality aquatic site. Also, recent work by the Missouri Resource Assessment Partnership on an aquatic biodiversity assessment (Sowa et al. 2004, 2007) should assist in defining high-quality aquatic natural communities.

- *Represent the characteristic natural communities and geologic features of each of the 31 terrestrial ecological subsections (Nigh and Schroeder 2002) and 19 aquatic ecological drainage units (Sowa et al. 2007) of Missouri.* For many ecological subsections or drainage units, high-quality examples of characteristic natural communities are lacking and irretrievably lost from the landscape. Natural areas should contain core areas of intact, high-quality natural communities or natural geologic features that meet criteria as significant or exceptional natural features as defined by the Missouri Natural Features Inventory (See Appendix B), and as defined in Nelson (2010), Pflieger (1989), and Hebrank (1989). Natural communities should ideally be represented in the Missouri Natural Heritage Database and have an element occurrence rank (grade) of "A" or "B" ("C" ranked occurrences may be allowed if restorable to a higher grade and/or for very rare natural community types).
- Be located in landscapes that are generally rich in native plant and animal species and characteristic natural communities, structurally diverse, contain relatively intact soils, and are devoid of quantities of invasive plant and animal species, particularly non-native species. Most of these landscapes have been identified as "Conservation Opportunity Areas" through the Missouri Comprehensive Wildlife Strategy (Figg and Linsenbardt 2005, Nigh 2005, Sowa et al. 2007).
- Contain adequate riparian vegetation zones around streams. Minimum riparian vegetation zone widths are: at least 50 ft. to either side of the stream bank for first and second order streams, 100 ft. to either side of the stream bank for third through fourth order streams, and at least 300 ft. to either side of the stream bank for fifth order and larger streams (Welsch 1991, Roell 1994, Schultz et al. 2000, USDA 2000).
- Where possible and practical, have boundaries follow watershed boundaries and natural landforms. Lesser quality natural communities and degraded open lands may be included as "buffer" within a designated natural area as long as the acreage of high-quality natural communities or restorable to high-quality natural communities comprises the bulk of the natural area. Note that ecological processes often depend on large areas that will often be outside of the natural area boundary (Poiani et al. 2000). For example, fens and springs may be dependent upon a large recharge zone to maintain hydrologic processes. Water quality and fen or spring functioning is likely dependent upon a much larger watershed than the immediate surface watershed around the fen or spring. Natural area designations should note these limitations on natural area protection and recommend continued work in priority watersheds for best land management practices that ensure adequate water quantity and quality.
- Generally lack buildings, paved or gravel roads, previously farmed lands, previously mined lands, utility right of ways, dams, bridges, game species food plots, farm ponds, and other land use impacts. However, exceptions do occur. For example, an electric transmission power line bisects part of St. Francois Mountains Natural Area (NA) on Proffit Mountain.
- Have boundaries large enough to allow for the implementation of management actions needed to maintain natural communities and their associated rare and declining species. If they are not, then the adjacent lands should have other designations (conservation easements, management agreements, public conservation lands) that will allow for the implementation of management actions and natural processes. For example, if the natural community requires prescribed fire, the natural area boundaries should either be large enough to accommodate the logistics of carrying out safe controlled burns or the adjacent lands should be in a land management category that enable firebreak construction and prescribed burns to be carried out on them.

Guiding Premises and Philosophy of Natural Area Management

- Native species have adapted and, in part, evolved with the natural evolutionary influences, including disturbance processes, of the Holocene (past 10,000 years) geologic period.
- The pattern and processes of natural communities over the last few thousand years (i.e., "presettlement") prior to widespread European settlement of Missouri (circa 1820s) are considered a benchmark of what we consider "natural" conditions (the "range of natural variability" *sensu* Kaufmann et al. 1994, Swanson et al. 1994, Landres et al. 1999). Native American populations impacted Missouri's landscape through the use of fire, hunting, fishing, firewood cutting, and some agriculture for at least the last 10,000 years. This anthropogenic influence resulted in the development of fire-adapted natural communities, which in the absence of such historic disturbance regimes, will degrade or be lost forever (Nowacki and Abrams 2008). The pervasive and intense land use (land clearing, intense agricultural production, drainage, etc…) of people in Missouri since the time of statehood (1821) and, certainly, since the turn of the 20th century have had wide-ranging and destructive influences to the state's biological diversity. Through the use of paleo-ecological, pedological, geological, archaeological, and historical data sources we have a conceptual model of presettlement conditions as described in Nelson (2010) and Nigh and Schroeder (2002). Natural areas management should not attempt to "freeze" a natural community exactly as described by the general land office surveyors of the mid 19th century but should emulate the range of historic disturbance regimes by which such natural communities accrued species richness.
- Natural communities are dynamic entities and a range of compositional and structural conditions are possible within the natural range of variability for a site. Furthermore, the climate has, is, and will be changing so we must recognize that there is often variation in natural community composition and structure at any given site at any given time (Sprugel 1991, Millar and Brubaker 2006).
- Restoration of natural communities may be needed because, today, most if not all of Missouri's natural communities are to some degree altered from their presettlement conditions. No "pristine" sites exist in Missouri except for, perhaps, unexplored caves and some cliff faces. Disturbance related effects or impacts from prescribed fires or wild fires and floods today yield different results than what they did 300 years ago. Composition of the landscape has been greatly altered and native large predators and grazers have been extirpated. In particular, Missouri's big rivers and many large rivers and their associated wetlands have been heavily altered by human impacts so severely that no true reference conditions remain. This means that restoration of a freshwater marsh in the Missouri River floodplain will never attain the degree of "naturalness" that a restored glade and woodland complex will in the lower Ozarks.
- Natural areas management seeks to maintain or restore ecological processes that shaped presettlement natural communities. Natural area managers should apply the sustaining natural processes (e.g., fire regime, hydrologic regime, native grazer patterns) that affected the formation and maintenance of natural communities. Once these processes are identified and implemented, natural area managers should use other control measures such as brush cutting or herbicides to supplement management efforts only when reestablishment of natural forces is insufficient to restore or maintain ecological integrity.

- Management practices that use or mimic presettlement ecological processes are necessary to maintain diverse, resilient, productive and healthy natural communities while maintaining or enhancing rare or declining native species.
- **The Precautionary Principle**: management actions should give the benefit of the doubt to the integrity of the natural community rather than to commodity production, public use demands, or research aimed at answering various natural resource questions. This principle is similar to that part of the Hippocratic Oath that states "First, do no harm." When in doubt about a management action on a natural area the manager should seek advice from other experts, including MoNAC representatives.
- **The Patience Principle**: restoration of natural communities is a long-term endeavor that may take decades to achieve. Consistently applying management practices over the years will produce results, and achieving desired conditions will often span more than one person's career.
- **The "Pick your Battles" Principle**: given limited funds, personnel, and time, the most threatening stressor of a natural community should always be targeted. For example, little effort should be extended controlling chicory (*Cichorium intybus*) growing along a roadside adjacent to a natural area when a population of garlic mustard (*Alliaria petiolata*) threatens the interior of the site. Similarly, a small infestation of fescue (*Festuca arundinacea*) on a prairie may be ignored to concentrate on a more serious problem with sericea lespedeza (*Lespedeza cuneata*). Safety issues, the human environment, laws, and agency policies all potentially limit or constrain the ability of natural area land managers to replicate or emulate historic disturbance processes (especially fire and flooding regimes).
- Public uses of natural areas should cause only minimal ecological impacts to natural communities. Appropriate public use and enjoyment of natural areas is encouraged.
- NNIS suppression or control, not eradication, is the goal for well-established NNIS infestations. However, new satellite infestations of NNIS should be eradicated if possible.

Natural Area Management Practices

Guidelines provide direction for the designation and management of Missouri Natural Areas. A guideline is a suggested course of action. Guidelines can also be meant to reduce or eliminate adverse effects to natural area resources. These guidelines are meant to be encompassing and flexible. MoNAC does not want these guidelines to be rigid. A guideline is a course of action that should be followed in most circumstances; however, certain area-specific factors allow for flexibility. Guidelines prescribe actions that field managers can fine-tune depending on site conditions. Guidelines depend on professional expertise to address specific resource management conditions. Natural area managers should give advance notification to MoNAC of planned activities that may be controversial. There is an expectation of consultation with MoNAC representatives on management planning.

MoNAC has kept the list of "typically incompatible" activities on a natural area to a minimum (Table 1). Even here, if a natural area manager has a demonstrated need to conduct a management operation listed as being a "typically incompatible" activity on a natural area, such an action can be done with good justification and input/review by MoNAC. Note these guidelines are trumped by emergencies and catastrophes.

Hopefully, having these guidelines will improve the understanding of natural area design and management approaches that complement the goals and objectives of the Missouri Natural Areas

Program (as outlined in the MoNAC MOU), and thereby facilitate cooperation and coordination among MoNAC partners. Guidelines include general ones for the entire Missouri Natural Areas System and more specific guidelines for individual management practices.

Limitations: Management recommendations of some existing designated natural areas may not meet the guidelines developed herein. In most cases, these natural areas were designated prior to 1990. Through time, older natural area management recommendations should be reviewed and revised to be consistent with these guidelines. In the meantime, natural area managers should use these guidelines and solicit guidance from their MoNAC representative(s) on specific questions or interpretations. Implementation, feasibility, operational considerations and other challenges will require discussions with respective natural area managers/administrators and or landowners. Planning for future natural area nominations should fully embrace the ideals contained herein. We also recognize management prescriptions for each candidate or designated natural area vary in complexity based on factors including ecological integrity, threats, management technique (e.g., prescribed burning), and natural area owner commitment/support. Last, these guidelines do not supersede specific organizations' applicable regulations and directives (unless the organization desires to do so). All MoNAC organizations and partners in the Missouri Natural Areas Program have differing missions and mandates. These guidelines apply to all designated natural areas and are broad in scope and generally lenient. More restrictive regulations for natural area design and management may be set by MoNAC organizations for lands they manage.

General Natural Area Management Guidelines

Table 1 contains a list of typically incompatible activities on designated natural areas. These activities can often have deleterious and irreversible negative effects on ecological integrity. Natural area managers should use these management actions cautiously and only after a thorough review and consideration of the potential effects by the respective agency's natural areas committee. MoNAC should also get advance notification and an opportunity to comment on management actions covered in Table 1.

Table 1. Activities typically incompatible with natural areas.

Keyword	Incompatible Activity	Comments
Agriculture	Agricultural lime	None
	Conventional livestock grazing	Continuous, production livestock operations are not allowed.
	Cultivating/Cropping	OK for previously tilled lands slated for native plantings. Limited discing of firebreaks around remote bottomland prairie/marsh sites may be necessary (e.g., Horton Bottoms NA).
	Fertilizers	Supplemental addition of soil nutrients (e.g., phosphorus) and micronutrients, except nitrogen, may be considered for former hay meadow prairies but further research (not to be conducted on natural areas) is needed first.

Table 1: continued. Activities typically incompatible with natural areas.

Keyword	Incompatible Activity	Comments
Agriculture	New food plots	Existing food plots may be grandfathered in for new designations but are not recommended.
	Plowing	OK for previously tilled lands slated for native plantings.
	Soil amendments	See agricultural lime and fertilizers above.
Boats	Motorized personal watercraft (e.g., jet skis)	Canoes, kayaks and electric powered boats are typically compatible. Gas powered boats may or may not be compatible and horsepower limits may be set on a case by case basis by the respective agency's natural areas committee.
Caves	Blocking cave entrances/sinkholes or cave airflow	Proper cave gate design and justification is needed. Treated on a case by case basis by the respective agency's natural areas committee with input from cave biology experts.
Collecting	Unauthorized collecting of plants, animals, soils, rocks, minerals, and archaeological artifacts.	Scientific collecting permit procedures on natural areas vary by ownership. Collecting of materials for compatible scientific purposes is generally permitted. Unauthorized collecting is prohibited.
Construction	Building construction, including structures, parking lots, shooting ranges, etc.	Board walks, overlooks, kiosks, etc. are compatible-type construction on natural areas. Small access parking lots on the periphery of natural areas installed on buffer lands are permissible.
	Developed campgrounds or picnic areas	Clearly define boundaries when adjacent to natural area.
	Earth moving disturbance (e.g., grading, dozing)	Earth moving can have many deleterious and long-term impacts. Approach any earth moving projects with caution, especially those impacting greater than an acre in size. Construction of firebreaks oftentimes utilizes dozers. Creating bladed dozer lines for prescribed fire management on natural areas requires caution and following best management practices to reduce soil movement. Limited discing of firebreaks around remote bottomland prairie/marsh sites may be necessary (e.g., Horton Bottoms NA).

Table 1: continued. Activities typically incompatible with natural areas.

Keyword	Incompatible Activity	Comments
Construction	New fishing ponds	None
	New wildlife ponds	Unless there is a justified need for additional fishless pools for amphibian/aquatic invertebrate habitat.
Invasive Species	Broadcast pesticide application	Certain invasive, exotic species infestations may require this approach with necessary cautions. Requires a thorough review process beforehand on a case by case basis by the respective agency's natural areas committee and invasive species experts. Existing utility line right of way management may require this type of management.
	Deliberate introduction of invasive, exotic species	None
	Introduction of biocontrol agents	Requires a thorough review process beforehand on a case by case basis by the respective agency's natural areas committee and invasive species experts.
Mining	Mineral exploration and mining (including gravel mining along/in streams)	Pre-existing mineral rights or laws may exist that allow for this.
Right of Way	New utility right of way (e.g., pipelines, power lines, cable lines)	Maintenance of a right of way present at the time of natural area nomination is continued as long as the right of way is in operation.
Silviculture	Production silviculture	Commercial harvests are handled on a case by case basis and must contribute to a natural area objective.
	Storm, insect/disease, or fire damage timber salvage	Only if a critical need exists with well-defined justification, e.g., clearing firebreaks, roads, and trails.
Streams	Altering natural water levels/flow regimes	None
	In-stream modifications	Unless to move toward desired condition for featured natural community. Handled on a case by case basis. Typically requires a 404 permit from the U.S. Army Corps of Engineers and a 401 permit from MoDNR.

Table 1: continued. Activities typically incompatible with natural areas.

Keyword	Incompatible Activity	Comments
Streams	Livestock grazing within riparian zones.	Excluding livestock from riparian zones is important and fencing should be used. When determining the extent to which livestock may have access to some or all of a defined stream channel, a field inspection is required and an interdisciplinary team should come to consensus on how to trade off adverse impacts.
	New low water stream crossings	Except in specific and well justified circumstances. Existing low water stream crossings should follow best management practices.
	Stream channel modifications	None
	Stream channelization	None
	Stream impoundments	None
Trails	New bike trails	Continued maintenance of bike trails present at the time of natural area nomination is customary.
	New horse trails	Continued maintenance of horse trails present at the time of natural area nomination is customary.
Trash	Dumping of waste or debris; littering	None
Vehicles	New construction of graded gravel or paved roads	Constructing or maintaining dirt access lanes and firebreaks is permissible but requires caution. Use best management practices.
	Public use of off-road vehicles (ORVs) and all-terrain vehicles (ATVs) and developed trails for these	Possible exceptions are for retrieval of deer killed by disabled hunters, to expedite a deer control program, emergency rescue, etc.
	Vehicle bridges	Except to facilitate critical management access.
Wetlands	Altering natural water levels/flow regimes	Unless current hydrology is degraded and water level/flow regime alteration is for restoration.
	Docks or floating structures	OK for research purposes.
	Dredging or tiling	None
	Earth moving disturbance (e.g., grading, dozing)	Unless there is a critical need to restore hydrology (e.g., sediment removal, ditch plugs). Reviewed on a case by case basis by the respective agency's natural areas committee and MoNAC is allowed an opportunity to comment.

Table 2 lists and describes various management practices, activities or tools used on natural areas and the sideboards for their use.

Table 2. General management guidance for Missouri Natural Areas.

Keyword	Management Activity	Guidance
Archaeological and Historic Resources	Maintaining historic structures and archaeological sites	Should be protected as per applicable state and federal laws and specific agency policy.
Buildings	Building demolition	Typically buildings and structures should not exist on a designated natural area. Non-historic structures should be demolished using the most site-sensitive techniques. Contact the MoDNR State Historic Preservation Office prior to any demolition efforts.
Dumps	Dump clean ups	Trash dumps should normally be eliminated and trash hauled to a proper landfill. However, in some cases it might be better to leave the dump intact if disruption of the dump site would cause excessive erosion or leachate issues if disturbed.
Erosion Control and Land Reclamation	Cropland and wildfire reclamation and road rehabilitation in or adjacent to natural areas	Revegetate abandoned crop fields and food plots and wildfire control lines and other disturbed lands as soon as practical, either with appropriate native species or through natural regeneration. Weed-free straw mulch and seeding of annual rye (*Secale cereale*) or wheat (*Triticum aestivum*) for erosion control is an acceptable practice.
	Head cut mitigation measures	Rock check-dams are sometimes installed (e.g., Helton Prairie NA) to mitigate for impaired drainage ways that are head cutting badly.
Pesticide Use	Herbicide use, for controlling invasive exotic and invasive native plants	Avoid when effective and feasible natural (e.g., fire) or mechanical (e.g., mowing) control measures exist. However, managers must use the best and most effective known treatments including use of pesticides and biocontrol agents if necessary and safe. Use as little of the least soil persistent and environmentally harmful chemical as will effectively kill the target species and follow all label directions. Avoid broadcast spraying of general purpose herbicides, or herbicide use that will significantly diminish concentrations of native plants, or rare species. Exceptions should be approved by the respective agency's natural areas committee.

Table 2: continued. General management guidance for Missouri Natural Areas.

Keyword	Management Activity	Guidance
Pesticide Use	Insecticide and fungicide use, for controlling: • invasive, exotic insects such as the gypsy moth (*Lymantria dispar*) and emerald ash borer (*Agrilus planipennis*) • exotic plant pathogens such as the "sudden oak death" disease caused by *Phytophthora ramorum* or thousand cankers disease caused by the fungi, *Geosmithia morbida* and the walnut twig beetle (*Pityophthorus juglandis*).	Methods and applications should seek to avoid or minimize damage to principle features of the natural area and should be approved by the respective agency's natural areas committee. MoNAC review and evaluation of insecticide or fungicide use is recommended. Must follow all applicable local, state, and federal regulations and abide by the label instructions.
	Piscicide use for chemically eliminating fish from wildlife ponds.	Used to kill or eliminate fish in man-made ponds that serve as important larval sites for amphibians. Not for use in streams or natural pond environments (unless the natural pond was artificially stocked with fish). Must follow all applicable local, state, and federal regulations and abide by the label instructions.
Public Use Structures	Interpretive signs and kiosks	Allowed near parking lots and border areas or along trails if approved by the respective agency's natural areas committee.
	Paved trails, boardwalks, and overlooks	Allowed when identified in the natural area's management recommendations and necessary to avoid impacts to sensitive features.
	Structures and improvements	Necessary signs, trash receptacles, and minor structures, including parking lots, are permitted on buffer lands and low quality natural community sites along the perimeter of the natural area.
	Trailside benches and visitor amenities	Only where approved by the respective agency's natural areas committee and designed to blend with the natural landscape.
Right of Way (ROW)/ Utility Lines	Utility right of way management	Control brush in ROW by mechanical cutting or prescribed fire rather than herbicide if possible. If herbicide must be used, limit to the least harmful chemical and apply in the most targeted feasible manner. It helps to meet on-site with contractors to ensure proper ROW management.

Table 2: continued. General management guidance for Missouri Natural Areas.

Keyword	Management Activity	Guidance
Right of Way (ROW)/ Utility Lines	Utility right of way management	Avoid heavy mechanical disturbances and chemical applications (except wetland-approved herbicides) within a 200-foot radius around wetland features.
Trails	Trail Design and Maintenance	Should be laid out or maintained to blend with the natural landscape, with minimal impact to the natural area's features. Should have no adverse impact on sensitive species, communities or features and be designed to minimize erosion. If identified as an acceptable practice in the natural area's management recommendations, paving materials, footbridges, boardwalks, overlooks, and elevated walks are allowable. New horse and bike trails are not allowed on natural areas.
Vegetation management	Grazing	Apply as a natural ecological disturbance process only to meet specified natural area goals for certain prairie and savanna landscapes. Native herbivores are preferred. MoNAC at this time cannot recommend using cattle or other domestic livestock as a grazer in patch-burn or other grazing systems on prairie/savanna natural areas until more long-term data are collected on the impacts of these practices on the native plant community. MoNAC recommends that this research be conducted on non-natural area sites. Excluding livestock from riparian zones is important and fencing should be used. When determining the extent to which livestock may have access to some or all of a defined stream channel, a field inspection is required and an interdisciplinary team should come to consensus on how to trade off adverse impacts. Grazing systems should be established in the site's natural area nomination and management recommendations. New proposals for grazing projects on designated natural areas must be approved by the respective agency's natural areas committee, and require MoNAC review. Grazing regimes should not erode the long-term floristic quality (Ladd 1996, Taft et al. 2006) of the plant community and include significant rest periods (2+ years). Grazing systems should minimize the introduction of invasive, exotic species and the physical and visual impact of grazing infrastructure (e.g., water lines, stock ponds). Visible interpretive signage should explain to natural area visitors how and why grazing is being used there.

Table 2: continued. General management guidance for Missouri Natural Areas.

Keyword	Management Activity	Guidance
Vegetation Management	Grazing (continued)	Stocking rates should be determined on a case-by-case basis by an interdisciplinary team with expertise in botany, plant ecology, range management, animal husbandry, wildlife ecology, soil science, and stream ecology. Stocking rates should reflect natural community and not commodity production goals.
	Haying	Haying for reasons other than establishing firebreaks is only done for specific restoration or management purposes per the site's management recommendations, or when endorsed by the respective agency's natural areas committee.
	Mowing and brush-hogging	Permissible under site management recommendations as an initial restoration measure, or where fire cannot be successfully applied, to control brush problems in prairie, savanna, open woodland, and marsh communities. Used for containment of exotic plant species as part of an integrated control approach. Used routinely to establish control lines for prescribed burns in grassland communities. Be careful that seeds from exotic plants are not introduced by equipment.
	Native seed harvest	Be cognizant of the amount of seed harvested. In general harvest no more than 50% of the seed of a population of a perennial species.
	Prescribed fire	This is the primary method of management for fire-adapted natural communities. Should operate within the historic range of variation, to sustain the composition and dynamics of the site. May be applied as a tool to reduce woody density or accomplish specific natural area restoration objectives. Control lines should not cause soil erosion, introduce non-native plants, or destroy desired elements of the natural vegetation.
	Tree thinning, deadening. or removal	Allowable where fire will not be sufficient to restore appropriate structure or composition to the tree layers. Recommended where soil erosion may result from repeated fire use in a dense, over-stocked area.

Table 2: continued. General management guidance for Missouri Natural Areas.

Keyword	Management Activity	Guidance
Vegetation management	Tree thinning, deadening. or removal (continued)	All proposals for commercial timber removal should be approved by the respective agency's natural areas committee and require MoNAC review. Use only to restore density and structure that meets the natural area management recommendations or approved restoration guidelines. Apply as a step in a designed natural community restoration sequence.
	Vegetation control by deliberate chemical or mechanical manipulation and or prescribed fire, grazing or water management.	Done with the objective to conserve, restore, maintain, or reconstruct a natural community or rare, threatened or endangered species habitat as outlined in a site's natural area management recommendations. Practices include prescribed fire, grazing, cutting of shrubs and trees, girdling trees, hand pulling or cutting of invasive species, application of herbicides, and other management practices necessary to alter vegetation structure.
	Water control or manipulation	Apply where necessary to meet natural area goals and restore hydrologic patterns, which are integral to the diversity and dynamics of the wetland natural communities. Use to restore altered drainage and flooding patterns, and manage or control invasive species. New proposals for water control projects on designated natural areas must be approved by the respective agency's natural areas committee, and reviewed by MoNAC.
Vehicle Use	Access lanes	Vehicle access lanes should be installed or maintained only where essential for patrol, fire control or other management activities. Such lanes should be closed to all except service and emergency vehicles. Lanes should involve a single vehicle width and clearing should be limited to around 15 feet in width. Construction of new access lanes should be approved by the respective agency's natural areas committee.
	Off-Road Vehicle (ORV) Use	Public use of ORVs and all-terrain vehicles (ATVs) is prohibited. Natural area managers and law enforcement officials may use ORVs and or ATVs for area maintenance and management or emergency rescue.

Table 2: continued. General management guidance for Missouri Natural Areas.

Keyword	Management Activity	Guidance
Vehicle Use	Off-Road Vehicle (ORV) Use (continued)	ORV use should normally be confined to existing roads, access lanes, and firebreaks. For prescribed fire and exotic species control projects ORVs can be used overland as long as soil disturbance is minimized. Use extreme caution when using ORVs or ATVs for management purposes on sensitive sites (e.g., fens, glades).

The Tool Box – Specific Management Tool Guidelines

Agricultural Cropping

Background: On some natural areas buffer lands may include small areas with a cropping history. The goal of these areas will be to get them back into an appropriate native vegetative cover.

Guidelines:

- Re-vegetate cropped lands as soon as practical with native Missouri plant species either through active planting or natural succession (depending on the site conditions).
- Cropped lands may remain in a cropped status for a few years to maintain a weed-free seedbed for a future native planting.
- Cropping may be utilized on a site with a cropping history to control severe infestations of invasive, exotic plants and to prep the site for a native planting. Cropping is also used to prepare the seedbed for native plantings on former crop grounds.

Cave and Spring Restoration and Management

Background: Caves, springs, and other karst features present unique management issues and challenges for natural area managers. Missouri has over 6,300 caves (Elliott 2000) and a number of these are protected on designated natural areas. Missouri is also home to thousands of springs, including some of the largest springs in the U.S. (Vineyard and Feder 1982). Because of their isolation and environmental conditions many endemic and or highly specialized cave animals (i.e., troglobites) are found in Missouri caves. Caves harbor a disproportionate share of rare species because of their unique natural communities (Culver et al. 1999). An excellent overall guide to cave conservation is found in Elliott (2004) and another general guide to cave conservation is published by the National Speleological Society (Hildreth-Werker and Werker 2006).

Protecting caves and springs requires an understanding of karst hydrology and protecting the recharge area from poor land use practices and water pollutant spills (Aley 2000). A karst landscape has been described as akin to a block of Swiss cheese, whereby water draining into a sinkhole in one valley may exit from a spring several miles away. The recharge area of a cave or spring is the land area which contributes water to the cave or spring. Cave recharge areas can include multiple surface watersheds. Protecting the water quality of runoff into sinkholes and losing stream segments is especially critical for cave and spring protection.

Non-point source water pollutants (e.g., fertilizer runoff), groundwater depletion from well pumping, sinkhole trash dumps, point-source pollutants (e.g., industrial discharges, failing

wastewater treatment facilities, confined animal feeding operation waste lagoons), and livestock access to losing streams all negatively affect cave and spring ecosystems (Zokaites 1997, Springfield Plateau Grotto 2009). Implementing karst protection typically involves working with a multitude of landowners and stakeholders in a recharge area.

Direct human use impacts to caves and the legacy of historic cave and spring commercial developments pose challenges to natural area managers. Human visitation, vandalism, and trash dumping in caves have degraded Missouri cave communities for centuries. Human disturbances can disrupt key life history stages of cave animals, such as the federally listed Indiana bat (*Myotis sodalis*) and gray bat (*Myotis grisescens*) (USFWS 1982). A difficult question for natural area managers is how much visitation to a cave is acceptable while maintaining the ecological integrity of the cave? There is no easy formula to determine the resource capacity for cave visitation (Elliott 2006). As a last resort to prevent human intrusions into caves, properly designed cave gates are often installed. Cave gating is a very technical subject and requires the input of cave biologist specialists. Good information on cave gates can be found in Elliott (1996), Tuttle and Taylor (1998), and Kennedy (2006).

Individual agencies and organizations have their own cave management policies. For example MDC classifies caves into three classes: I) unrestricted public use, II) restricted public use, and III) closed to public use (MDC Area and Resource Management Manual 2010) depending on the resources and hazards of the cave. In Missouri, caves are protected from vandalism, trespass, and water pollution by the Missouri Cave Resources Act. Caves on federal lands are protected under the Federal Cave Resources Protection Act.

Guidelines:

- Do not block or modify cave entrances without consulting cave biologist specialists and seeking input from the respective agency's natural areas committee.
- Signs explaining cave use restrictions should be posted at or within the cave entrance.
- Cave gates installed to protect cave resources should be designed to be bat-friendly and allow for proper air, water, and organic matter flow into and out of the cave. Consult cave biology specialists and seek input from the respective agency's natural areas committee before installing new cave gates. New cave gates should follow Bat Conservation International and American Cave Conservation Association standards.
- In general, caves utilized by sufficient numbers of Indiana and gray bats should be gated with properly designed cave gates.
- Caves used by Indiana or gray bats for hibernation should be closed September 1 to April 30. Gray bat maternity caves should be closed April 1 to October 30. Some bat caves are both hibernacula and maternity sites and should be closed all year except for scientific purposes.
- Caves on natural areas with significant biological, geological, archaeological or paleontological resources should be considered for protection through gating. For example, cave gates protect a number of biologically significant caves on designated natural areas.
- Even cave gates may not thwart some vandals or unscrupulous cavers and remote surveillance or law enforcement patrols may be needed.
- Since 2006, a very disturbing malady of cave-dwelling bats, known as White-Nose Syndrome (WNS), has been reducing cave bat populations in the northeast U.S. and as of 2010 had reached as far west as Oklahoma. Since 2006, bat mortality rates of > 75% have been documented at some surveyed cave bat hibernacula. The causal factor of bat

mortality from WNS is the fungus *Geomyces destructans*. This cold-loving fungus may be originally native to Europe. As of June 2010, bat caves in Pike and Shannon Counties, Missouri, have had bats that tested positive for this fungus. The USFWS is recommending actions to slow the spread of WNS by having cave managers place a voluntary moratorium on caving in significant bat caves until more is learned about WNS. They recommend that the only caving that should go on in significant bat caves be agency-sanctioned research and monitoring cave trips with appropriate decontamination protocols. Although the transfer of the fungus is primarily thought to be bat to bat there is also the possibility of human transference of fungal spores between caves. Keeping caves closed to human entry also limits human disturbance to bat populations that may already be stressed by WNS. Currently (2010) all MoNAC organizations have instituted some level of cave closures in response to WNS concerns. For current details contact a cave biologist and check the USFWS website for WNS (see URL: http://www.fws.gov/whitenosesyndrome/).

- Develop cave visitation standards on a cave by cave basis in consultation with a cave biologist and consultation/review with the USFWS if the cave contains federally listed species.
- Cave visitation should focus cavers on designated narrow paths that try to minimize trampling impacts to cave fauna and degradation of speleothems.
- Personal waste products and trash should be carried out of the cave during cave visits.
- Caves that have suffered trash dumping and graffiti should be considered for restoration but consult with a cave biologist to develop a restoration plan (also consult with the USFWS if the cave contains federally listed species).
- Foot trails should be diverted away as practical from cave entrances, springs, spring runs and sinkholes. Alternatively, foot trails near sensitive features may be "hardened" with boardwalks to limit foot traffic impacts. Horse and bike trails should be kept at least 100 ft. away from sensitive karst features.
- Maintain a 10 acre wooded buffer around all cave entrances and spring outlets and a 20 acre wooded buffer around caves that support Indiana or gray bats. Prescribed fire, thinning, and careful spot treatments of herbicides may be used within the buffer zone, but wholesale canopy removal or broadcast herbicide applications are prohibited. Maintain at least a 30% mature tree canopy cover in the buffer.
- Maintain a minimum 100 ft. wide wooded buffer along spring runs and corridors connecting cave entrances to nearby stream corridors. A 200 ft. wide wooded corridor buffer should be used for gray bat caves. Buffers can be prescribe burned and thinned, and careful spot treatments of herbicides applied, but wholesale canopy removal or broadcast herbicide applications are prohibited. Maintain at least a 30% mature tree canopy cover in the buffer.
- General application of pesticides should be avoided within a minimum 100 ft. radius buffer around all sides of cave entrances, springs, and sinkholes.
- Keep fuel, oil, and pesticide container field storage locations ("staging areas") during land management projects at least 100 ft. away from cave entrances, losing streams, and active sinkholes.
- Earth-disturbing projects within karst areas should deploy appropriate erosion and sediment control practices.
- Biological surveys and monitoring are crucial tools for proper management of caves on natural areas. Consult with a cave biologist for designing inventory and monitoring projects.

- Work with geologists and or hydrologists to identify cave and spring recharge areas as time and budgets allow. Focus recharge area delineation on the highest priority caves and springs (as identified by cave and karst specialists). Identify karst groundwater contamination vulnerability areas within the recharge area (e.g., railroad lines or pipelines near losing streams and sinkholes).

Erosion Control/Reclamation

Background: Previous land uses in buffer areas of natural areas may have created erosion issues or barren lands (e.g., old cropfields, abandoned roads). Left unchecked these areas may degrade adjacent natural communities through siltation and or further erosion.

Guidelines:

- Conservation plantings and other techniques (e.g., silt fence) may be used to stabilize soil and abate human-caused soil losses.
- Use native Missouri species in erosion control or reclamation plantings to achieve long-term soil stabilization. However, non-invasive non-native annual species such as annual rye or wheat can be used as a cover crop in establishing erosion control cover.
- Develop larger erosion control plans in consultation with the local Natural Resources Conservation Service (NRCS) office and MoDNR Soil and Water Conservation Program staff.

Grazing:

Background: Bison (*Bison bison*) historically occurred in Missouri but were rapidly eliminated by European settlement. The Lewis and Clark expedition in 1804 did not spot any bison until near present day Kansas City (Schroeder 1981). Schwartz and Schwartz (2001) noted that accounts of bison immediately preceding European settlement are too vague to make any detailed estimates of abundance or distribution. They noted that elk (*Cervus elaphus*) also ranged across the state in the presettlement period. Historically, bison and elk would have ranged across over 24,000 square miles of Missouri prairies and savannas. Given this once vast native grass and forb dominated landscape, native grazers may have only grazed the same area every few years or more. Schwartz and Schwartz (2001) indicated that by 1840 both large native grazers were reduced to remnant populations. Bison and elk were an important factor in the structuring of presettlement prairie and savanna communities throughout the tallgrass prairie biome (Knapp et al. 1999). However, two centuries of overgrazing by domestic livestock (mainly cattle and hogs) after removal of bison and elk has caused severe ecological degradation of natural communities across Missouri.

Ideally, bison and elk would be a part of the natural disturbance regime of today's prairies, savannas, and woodlands. But today, landscape scale prairies or savannas (>1000 acres) are represented by less than a handful of sites in Missouri. Some of these areas may be feasible to consider implementing grazing by bison and or elk. Logistical, economic, and socio-political factors also impede the use of bison and elk grazing on natural areas. To date, the only long-term use of bison or elk grazing in combination with prescribed fire in Missouri has been at Prairie State Park in Barton County. Bison have been at the park since 1985 and elk since 1994. Plans are currently underway at The Nature Conservancy's Dunn Ranch Preserve in Harrison County to utilize bison grazing in combination with prescribed fire on the site's prairie landscape.

Recently, a renewed interest in utilizing a management system that uses prescribed fire to control grazing distribution, i.e., patch-burn grazing, has been studied in the tallgrass prairies of Oklahoma and Kansas using both bison and domestic cattle (*Bos taurus*). These studies have demonstrated that a patch-burn grazing system can produce greater spatial heterogeneity in vegetation that provides greater variability in the grassland bird community (Fuhlendorf and Engle 2001, 2004; Fuhlendorf et al. 2006,

Churchwell et al. 2008), including greater abundances of bird species of conservation concern such as the Upland Sandpiper (*Bartramia longicauda*) and Greater-Prairie Chicken (*Tympanuchus cupido*). MDC implemented a patch-burn grazing system in 2005 with domestic cattle on certain MDC prairies and prairie natural areas (Taberville Prairie, Niawathe Prairie) as part of an adaptive management experiment (Jamison and Underwood 2008). This five year project demonstrated positive effects of the treatment for the grassland bird community (including declining prairie bird species) and no apparent negative effects on the floristic quality index (*sensu* Ladd 1996). But this short term study provides little guidance on appropriate return intervals for patch-burn grazing with cattle for maintaining the ecological integrity of the plant community in balance with restoring declining grassland bird species. Questions regarding the proper intensity of grazing for prairie biodiversity management also remain. Because of the lack of long-term data (10+ years) on the impacts of patch-burn grazing with cattle on the plant, insect, herptile, and small mammal communities of Missouri tallgrass prairie remnants this management practice cannot be recommended by MoNAC for use on prairie natural areas at this time. Furthermore, MoNAC could not reach a consensus on this management practice at this time. Managers should think of grazing as a tool to restore and maintain the rich animal and plant diversity of our native prairies. With less than 100 square miles of native prairie left (99.6% having been destroyed) in the state, it behooves prairie natural area managers to err on the side of caution with respect to deploying grazing systems on prairies.

Guidelines:

- Grazing should only be used in prairie and savanna communities.
- Native herbivores are preferred.
- Grazing, as a management tool, is used on natural areas explicitly for the primary purpose of emulating a historic disturbance process that is functionally important to the adaptation and maintenance of plant and animal diversity.
- MoNAC at this time cannot recommend using cattle or other domestic livestock as a grazer in patch-burn or other grazing systems on prairie/savanna natural areas until more long-term data are collected on the impacts of these practices on the native plant community. MoNAC recommends that this research be conducted on non-natural area sites.
- Grazing should only be used on large (generally >300 acres), good quality prairies and savannas with gentle slopes and minimal NNIS infestations and eroded areas.
- Grazing should be managed in a manner that emulates the timing, duration, and frequency of native grazers. These include diversification of treatments and allowing only portions of the management unit to receive occasional grazing disturbance. There are a variety of possible grazing systems to use.
- The number of permitted livestock should be matched with the available forage being produced in the system without overgrazing of the forage and especially undue pressures on grazing decreaser plant species (plants that decrease with continuous grazing).
- Stocking rates (and the ages and sex of stock) should be determined on a case by case basis by a team including persons knowledgeable in botany, community ecology, rangeland science and management, grassland birds, fisheries/aquatic ecology, and animal science and husbandry.
- Managers should have the flexibility to remove grazers once management objectives have been reached.
- Grazing systems should include significant periods of growing season rest. At a minimum two full years of rest should be used in between grazing treatments.
- Long-term monitoring of the effects of grazing on the plant community, including the floristic quality index (Ladd 1996, Taft et al. 2006) should be a component of any natural area managed with grazing.

- Care must be taken in the installation of fencing and water sources for stock in terms of limiting impacts to prairie vegetation and soils.
- Concerns for rare, threatened and endangered species that are sensitive or potentially sensitive to grazing impacts should be addressed in grazing system plans.
- Grazing should not be allowed in areas with large infestations of non-native and invasive plant populations, unless designed specifically for the control of such infestations.
- Livestock should be kept out of streams in general. A current exception has been made for bison and elk access to streams at Regal Tallgrass Prairie NA. Excluding livestock from riparian zones is important and fencing should be used. When determining the extent to which livestock may have access to some or all of a defined stream channel, a field inspection is required and an interdisciplinary team should come to consensus on how to trade off adverse impacts.
- Interpretive signing should be used for all grazing projects on natural areas explaining to area visitors why and how grazing animals are being used as a management tool.

Haying

Background: Haying has been used for a century or more as a method of managing Missouri's remnant prairies. Ironically, the use of remnant prairies as hay meadows protected them from conversion to row crops or non-native pasture grasses but also left a legacy of degradation of plant species composition (Leahy and Smith 1997, Jog et al. 2006, Clubine 2007, Nelson 2010), erosion of genetic diversity for Mead's milkweed (*Asclepias meadii*) and presumably other species (Bowles et al. 1998), and decreases in soil phosphorus, potassium, and possibly micronutrients (KSU 1992, Meinert 2008). Annual haying leads to increases in broomsedge (*Andropogon virginicus*) and decreases in mid and late season forbs. Haying does not replace or fully mimic the effects of prescribed burns. Haying can also have detrimental effects on snake and bird populations. Haying is not a preferred management technique for prairie but is done out of practical necessity to keep up with the need for disturbance given staffing and budgetary constraints as part of a rotation with prescribed burning, rest, and sometimes grazing.

Guidelines:

- Require producers to clean their equipment before haying the site to prevent the spread of weed seeds.
- Move away from haying management and use more prescribed fire as practical.
- Avoid annual haying of prairies.
- Hay at most every three years.
- Haying should occur after July 15th after most ground nesting birds have fledged their first brood. Hay before the end of August if possible.
- Hay only once in the growing season.
- Strive to leave four inches of stubble for re-growth and soil cover.
- Try to hay only 1/3 of the prairie in a year.
- Haying can be used as a technique to obtain seed for restoration and reconstruction efforts following the guidance listed above.

Mowing/Brush-hogging

Background: Mowing or brush-hogging vegetation is a typical and routine management practice to maintain access/fire lanes and modify vegetation structure on natural areas.

Guidelines:

- Require operators to clean their equipment before mowing the site to prevent the spread of weed seeds.
- Mow when soils are sufficiently dry or frozen to avoid rutting and compaction.

- Mowing in the growing season should occur after July 15th after most ground nesting birds have fledged their first brood.
- Strive to leave four inches of stubble for re-growth and soil cover if mowing a field area.
- Avoid annual mowing of areas unless part of a NNIS control technique or to maintain firebreaks.

Native Invasive Species Control

Background: Alterations in natural processes and habitat fragmentation have resulted in many native species becoming "invasive" in certain situations. With the suppression of fire, overgrazing, loss of native predators, indiscriminant logging, and or changes in hydrology, many natural communities quickly succeed to weedy native tree and shrub species. For example, eastern red cedar (*Juniperus virginiana*) is a highly invasive native woody species of glades, prairies, savannas, and woodlands in the absence of fire (Nelson 2010). In wetlands impacted by artificial drainage efforts, flood control structures, and or fire suppression, willows (*Salix* spp.) and other early successional woody species may encroach on formerly open marshes, bottomland prairies, and fens. The use of thinning and prescribed fire to control native invasive plant species in fire-adapted ecosystems is a common practice.

White-tailed deer (*Odocoileus virginianus*) and beaver (*Castor canadensis*) are two native mammals that can cause unacceptable levels of damage to natural communities. Unprecedented populations of white-tailed deer are causing tremendous ecological damage to natural communities across the eastern U.S. (Côté et al. 2004, Rooney 2004). A growing body of evidence indicates that deer overabundance facilitates the invasion of the NNIS garlic mustard and Japanese stilt grass (*Microstegium vimineum*) in forests by preferential browsing of native plants and the creation of bare soil areas (Knight et al. 2009). In addition to negative impacts to forests, deer overabundance has also been shown to cause negative impacts to prairie forbs (Anderson et al. 2005). Signs of overbrowsing by deer include: significant clipping of understory shrubs, vines, and saplings; decreases in sensitive species (e.g., trilliums) at the expense of browsing increaser species (e.g., ferns and sedges), browse "lines," and an excess of deer trails or runs.

Beaver are in general a welcome species in Missouri's landscape and have been important creators of wetlands in headwater creeks and other locations for thousands of years. However, inundation of high-quality fens and acid seeps by beavers is an unacceptable impact in today's degraded landscape. Historically, beavers would have sporadically inundated fens and seeps in a valley here and there but the landscape was rich in fens and seeps so that the overall impact to these communities in aggregate was minimized.

Guidelines:

- Invasive native plant species, e.g., eastern red cedar, smooth sumac (*Rhus glabra*), winged sumac (*Rhus copallina*), willows, and elms (*Ulmus* spp.), should be controlled where they threaten to take over open fire-adapted community types and/or wetland community types (e.g., glades, prairies, savannas, woodlands, marshes, and fens).
- Deer populations should not be allowed to damage the ecological integrity of natural areas by severely reducing native plant species abundances.
- Natural area managers should evaluate and assess natural areas for potential deer browse damage and establish vegetation monitoring and deer census techniques to measure the extent of damage.
- Hunting should be used to keep deer population levels down. Generally hunting is the best method to achieve deer population control.
- Managers should strive to keep deer densities below 25 deer/mi^2 (Anderson 1994, Horsley et al. 2003).
- Managers should work with the MDC on implementing successful deer management programs.

- Beaver dams causing inundation of fens or acid seeps should be breached and the beavers trapped and killed or removed. Beaver pond "Clemson levelers" may be installed to assist in preventing beaver flooding of sensitive wetlands.

Native Species Reintroductions and Augmentation Efforts

Background: Reintroduction is defined as the establishment of a species that was recently lost from part of its historic range (Maryland DNR 2009). Augmentation is a type of reintroduction defined as adding conspecific individuals to an existing population to enhance populations which remain within a species historic range (North Carolina Plant Conservation Program 2005). In many natural areas, buffer areas need to be re-vegetated with native plant species (Packard and Mutel 1997), i.e., "augmentations." In other cases, natural areas are selected for reintroduction of rare, threatened or endangered species to assist in recovery efforts (Falk and Holsinger 1991, Reinartz 1997).

Reintroductions of rare species have occurred on Missouri Natural Areas. For example, the federally listed Virginia sneezeweed (*Helenium virginicum*) was reintroduced to Tingler Prairie NA as part of the species recovery effort. Eastern collared lizards (*Crotaphytus collaris*) were reintroduced to portions of Stegall Mountain NA. Planning is underway to consider the reintroduction of the federally listed Topeka shiner (*Notropis topeka*) into streams at Pawnee Prairie NA and Spring Creek Ranch NA. Augmentation of common native species has occurred at many natural areas. For example, at Regal Tallgrass Prairie NA and Helton Prairie NA, natural area managers have used on-site collected prairie seed and hay to add to former cropfields adjacent to prairie remnants.

Guidelines:

- Reintroductions of rare species should be preceded by an analysis of the need, review of the species biology (especially reproductive biology and genetic diversity), causes of the species' rarity, potential for dispersal, and potential for adverse effects to other native taxa (American Fisheries Society 2009).
- Plans for reintroductions of species of conservation concern (Missouri Natural Heritage Program 2010) should be reviewed by a conservation geneticist and will require all necessary state and federal permits.
- Guidance should be sought from MoNAC regarding any planned reintroductions of any state endangered (Missouri Wildlife Code) or federally threatened or endangered species (Endangered Species Act) on designated natural areas.
- Reintroduced native species should come from source populations as close to the reintroduction site as practical. In general, source propagules should be from the same ecological section or aquatic subregion as the reintroduction site.
- As a rule of thumb, reintroduced plant species propagules should be from $\leq$ 200 miles to the north or south or $\leq$ 150 miles to the east or west (Apfelbaum et al. 1997).
- Species selected for reintroduction should have either historically occurred on the site or their predicted historic range should include the reintroduction site.
- Avoid reintroduction of aggressive cultivars, varieties, forms or subspecies of native species.
- Nursery or hatchery propagation of a limited set of wild-collected propagules is the preferred source of restoration propagules.
- Augmentation of existing, natural populations of rare species should be done carefully and use propagules from the population to be augmented.
- Reintroductions should be conducted with thorough documentation of propagule collecting methods and sources, methods of raising new organisms, and establishment techniques.
- Reintroductions should be restricted to sites that contain sufficient habitat to support a viable population.

- Be careful that reintroduced organisms do not carry with them unwanted parasites and diseases.
- Regular monitoring of introduced populations should be conducted to determine initial survival, recruitment of young, and population persistence.

Non-Native Invasive Species Control

Background: The definition of a non-native invasive species (NNIS) is a plant, animal, fungus or microbe that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm (after Federal Executive Order 13112). After habitat destruction and degradation, NNIS cause the most stress to native species (Wilcove et al. 1998, Mack et al. 2000). NNIS cause significant reductions in native species populations, severe alternations of natural communities, and or significant changes in ecosystem processes. Even with NNIS there is the need to prioritize work on the worst invaders. NNIS are here to stay in Missouri and new ones will continue to arrive. There is the need for work on the national and international level to slow the spread of NNIS across the globe but for the natural area manager in Missouri he or she will need to keep appraised of current and predicted biological invasions.

NNIS – Terrestrial Plants

Randall et al. (2008) present a method for categorizing nonnative plants according to their negative impacts on biodiversity at the state or regional level. Over 500 U.S. exotic plant species have been assessed for their invasiveness and given a ranking that is available by doing species specific searches from the NatureServe Explorer website (URL: http://www.natureserve.org/explorer/index.htm), and the process is ongoing to develop a national list of nonnative plant species that threaten biodiversity. The Missouri Botanical Garden's website contains a list and threat ranking of exotic, invasive Missouri plants (URL: http://www.mobot.org/mobot/research/mepp/welcome.shtml). Excellent information on the control of nonnative invasive plant species is found at the archived website of the former Nature Conservancy Global Invasive Species Team (URL: http://www.invasive.org/gist/). The Illinois Nature Preserve Commission's website contains an updated version of the Illinois Vegetation Management Manual that contains lots of useful information on the control of typical Missouri exotic, invasive plant species (URL: http://dnr.state.il.us/INPC/Management_guidelines.htm). See Miller (2004), Czarapata (2005), and the Midwest Invasive Plant Network (URL: http://mipn.org/) for excellent information on plant NNIS impacting Missouri. Table 3 below outlines the most troublesome plant NNIS of natural areas in 2010. The Missouri Department of Agriculture currently regulates a dozen exotic species as noxious weeds (http://www.moga.mo.gov/statutes/c263.htm).

NNIS – Aquatic Species

MDC has developed and implemented an Aquatic Nuisance Species Management Plan (2007) that contains details on exotic, invasive aquatic species that threaten Missouri aquatic natural communities. Twelve aquatic NNIS are already found in Missouri waters and nine additional aquatic NNIS may arrive in the near future according to the Plan. For aquatic biota, even aquatic species that are native within the political boundaries of Missouri can be invasive if they are moved into drainages where they are not native. These "inter-basin" transfers of species can be highly damaging to native ecosystems. Aquatic NNIS have been implicated in the decline of over 70 native fish species nationwide (Warren and Burr 1994).

According to the 2010 Wildlife Code of Missouri the following exotic aquatic species may not be purchased, sold, imported, exported, transported or possessed in Missouri: black carp (*Mylopharyngodon piceus*), snakehead fish of the genera *Channa* or *Parachanna*, walking catfish of the family Clariidae, zebra mussel (*Dreissena polymorpha*), mitten crabs (genus *Eriocheir*), rusty crayfish (*Orconectes rusticus*), Australian crayfish (genus *Cherax*), quagga mussel (*Dreissena rostriformis*

bugensis), mysterysnails of the genus *Cipangopaludina*, and the New Zealand mudsnail (*Potamopyrgus antipodarum*).

Currently occurring aquatic NNIS in Missouri include plants: dotted duckweed (*Landoltia punctata*), Eurasian water milfoil (*Myriophyllum spicatum*), brittle naiad (*Naias minor*), and purple loosestrife (*Lythrum salicaria);* fishes: common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), bighead carp (*Hypophthalmichthys nobilis*), and white perch (*Morone americana*); mollusks: Asian clam (*Corbicula fluminea*); mussels: zebra mussel; and crustaceans: water flea (*Daphnia lumholtzi*).

Aquatic NNIS of likely future entry into Missouri include: water hyacinth (*Eichhornia crassipes*), hydrilla (*Hydrilla verticillata*), New Zealand mudsnail, quagga mussel, rusty crayfish, northern snakehead fish, black carp, ruffe (*Gymnocephalus cemuus*), didymo (the diatom *Didymosphenia geminata*), viral hemorrhagic septicemia (a fish pathogen), and round goby (*Neogobius melanostomus*). Currently zebra mussels are established in the Lake of the Ozarks, Bull Shoals, Lake Taneycomo, Pomme de Terre, Smithville, and Stockton reservoirs; the entire stretch of the Mississippi River bordering Missouri, and the Missouri River (Banek, 2010). Zebra mussels were first reported in Missouri in the Mississippi River in 1991 and were found in Lake of the Ozarks in 2006.

There are no native trout species in Missouri and since 1878 non-native trout species have been introduced into a number of Missouri's coldwater streams for trout fisheries (Pflieger 1997, Kruse 2003). Today, MDC and MoDNR support the stocking and management of trout as part of a multi-million dollar trout fishing industry. There are no documented negative impacts to native aquatic fauna from trout in Missouri (Kruse 2003). But the introduction of non-native trout species have had documented negative impacts on native aquatic fauna in other states via predation and competition effects (Moyle et al. 1986, Townsend 2003, Dunham et al. 2004). Trout cannot be considered "invasive" at this time but natural area managers, administrators, and scientists should recognize the potential impacts of trout stocking on stream and spring natural communities.

Other NNIS

Non-native, invasive fungal and viral pathogens pose particularly intractable problems for native biota. Pathogenic NNIS fungi that have affected Missouri native trees include chestnut blight (*Cryphonectria parasitica*), dutch elm disease (*Ophiostoma ulmi*), and butternut canker (*Sirococcus clavigignenti-juglandacearum*). The chytrid fungus is currently negatively impacting the eastern and Ozark hellbenders (*Cryptobranchus alleganiensis alleganiensis* and *Cryptobranchus alleganiensis bishopi*, respectively) in many Ozark coldwater streams (Utrup and Mitchell 2008). West Nile virus (*Flavivirus*) has impacted bird populations to some degree. The fungus *Geomyces destructans* is the causal pathogen for the white-nose syndrome malady that is decimating many cave dwelling bat populations of the eastern U.S. and is now known from Missouri caves. This fungus may have originated in Europe. Other pathogens that have not yet been recorded in Missouri but could cause natural community degradation include: sudden oak death syndrome (*Phytophthora ramorum*), dogwood anthracnose (*Discula destructiva*), thousand cankers disease of black walnut (*Juglans nigra*), and beech bark disease (*Nectria cocci*).

Non-native, invasive insects that are currently affecting natural communities include the well-established Japanese beetle (*Popillia japonica*), and the highly destructive emerald ash borer (*Agrilus planipennis*) that was first discovered in Wayne County, Missouri in 2008. It is highly likely that more exotic insects destructive to native trees and shrubs will become established in Missouri in the future.

Table 3. Invasive, exotic plant species and natural communities typically invaded as of 2010.

Natural Community Type	Invasive, exotic species
Prairies, Glades, Savannas	Sericea Lespedeza (*Lespedeza cuneata*), Autumn Olive (*Elaeagnus umbellata*), Teasels (*Dipsacus laciniatus* and *fullonum*), Sweetclovers (*Melilotus alba* and *officinalis*), Tall Fescue (*Festuca arundinacea* and *pratensis*), Cheat Grasses (mainly *Bromus tectorum* and *japonicum*), Spotted Knapweed (*Centaurea stoebe*), Johnson Grass (*Sorghum halapense*), Crown Vetch (*Securigera varia*), Chinese Silvergrass (*Miscanthus sinensis*), Eurasian Bluestem (*Bothriochloa bladhii*), potentially Leafy Spurge (*Euphorbia esula*)
Marshes, Bottomland Prairies, Prairie Swales	Reed Canary Grass (*Phalaris arundinacea*), Purple Loosestrife (*Lythrum salicaria*), Japanese Knotweed (*Polygonum cuspidatum*), Phragmites (*Phragmites australis*)
Woodlands	Sericea Lespedeza, Bush Honeysuckles (*Lonicera maackii* and *morrowii*), Autumn Olive, Garlic Mustard, Asian Bittersweet (*Celastrus orbiculatus*), Multiflora Rose (*Rosa multiflora*), Japanese Honeysuckle (*Lonicera japonica*), Common Buckthorn (*Rhamnus cathartica*)
Forests	Garlic Mustard, Bush Honeysuckles, Japanese Stiltgrass (*Microstegium vimineum*), Wintercreeper (*Euonymus fortunei*), Air Potato (*Dioscorea oppositifolia*), Autumn Olive, Japanese Honeysuckle, Burning Bush (*Euonymus alatus*), Periwinkle (*Vinca minor*), Tree of Heaven (*Ailanthus altissima*), Kudzu (*Pueraria lobata*)
Stream Edge Communities	Sericea Lespedeza, Cheat Grasses, Japanese Knotweed, Spotted Knapweed, Teasels, Air Potato, Johnson Grass, Reed Canary Grass, Crown Vetch
Acid Seeps, Fens	Reed Canary Grass, Japanese Stiltgrass, Purple Loosestrife, Japanese Honeysuckle

NNIS can include mammals as well, and over the last decade populations of feral hogs (*Sus scrofa*) have become established in Missouri to the detriment of natural communities, particularly in the St. Francois Mountains, Wappapello Reservoir, and Truman Reservoir regions of the state (Hartin 2006). Feral hogs can cause localized destruction of glades, fens, seeps and other sensitive habitats.

NNIS Control Options

Control options for infestations of aquatic NNIS in streams and large reservoirs is limited to slowing the spread primarily by preventing the introduction from contaminated boats and other aquatic gear and the accidental introduction of live baits as well as deliberate species dumping into waters. Control in smaller reservoirs and ponds may be feasible using biocides (e.g., rotenone), electric shocking, draw downs, and fishing gears. Control of plant NNIS typically relies on mechanical methods (e.g., cutting, mowing), chemical methods (herbicides), and reinstating natural processes (e.g., fire). Controlling insect NNIS such as gypsy moth (*Lymantria dispar*) usually involves using a combination of silvicultural techniques (e.g., sanitation cuttings), pheromone disrupters, and insecticides (chemical, bacteriological, viral). Treatment of pathogenic NNIS including fungi and viruses is quite problematic and usually impractical and ineffective at the community level scale. Treatment of high-profile NNIS affecting economically important trees, agricultural crops, and animals will involve the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) which has the authority for federal regulatory

action of pest species (URL: http://www.aphis.usda.gov/). NNIS affecting trees are of large concern to the U.S. Department of Agriculture's Forest Service and they have a Forest Health Protection Program (URL: http://www.fs.fed.us/foresthealth/management/fhm-invasives.shtml).

In some cases, control measures for NNIS include using biological control, whereby a herbivore, predator, or parasite of the NNIS is introduced to control the target species. Successful biological control methods deployed in the U.S. have included release of two weevil species (*Rhinocyllus conicus*, *Trichosirocalus horridus*) for control of musk thistle (*Carduus nutans*) and the release of four weevils (*Hylobius transversovittatus*, *Galerucella calmariensis*, *Galerucella pusilla*, and *Nanophyes marmoratus*) for control of purple loosestrife. All biological control releases require the approval of the U.S. Department of Agriculture. Note that biological controls run the risk of unintended consequences and the risk factors must be weighed carefully.

Guidelines:

- Control efforts need to focus on those non-native species that are invasive, i.e., they present the most threat to our natural communities.
- Prioritize control of NNIS on the most invasive and injurious to the natural community. For example, in a prairie an infestation of sericea lespedeza would be a higher priority for control than controlling multiflora rose. Prioritizing treatment of NNIS should consider the species and its aggressiveness and threat to the natural community, location of the infestation, and size of the infestation.
- Detect and eradicate newly established NNIS.
- Focus on control, not eradication, for well-established NNIS depending on the species and its location.
- At least annually monitor for the presence of NNIS on natural areas.
- Use an integrated pest management (IPM) approach that utilizes a decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage by cost-effective means while posing the least possible risk to people, natural heritage resources, and the environment (USDA Forest Service 1998).
- New introductions of NNIS should be prevented as much as practical.
- The use of pesticides should be avoided if effective and practical mechanical or natural process (e.g., fire) control measures exist for controlling NNIS.
- Pesticide use to control NNIS should follow best management practices and follow all label instructions.
- Pesticide use should be targeted (spot treatments) and not broadcast applied unless for a specific and well-justified need (e.g., exotic species monocultures).
- Be especially careful with the use of pesticides in or adjacent to wetlands, karst terrain, and waterways.
- The lowest dosage of the least toxic and least persistent pesticide consistent with effective selective control should be used on natural areas. In most cases herbicides are required for effective plant NNIS control.
- Biological controls should only be used on natural areas for control of highly destructive and invasive species (e.g., purple loosestrife).
- Biological controls need to be approved by the U.S. Department of Agriculture APHIS and the U.S. Environmental Protection Agency before widespread releases occur. This has been the case with release of *Galerucella* beetles for control of purple loosestrife in Missouri.
- Biological controls should have documentation that they have no effect or little effect on non-target species. These controls should have a history of releases and documented well known effects before release onto a natural area.

Prescribed Fire

Background: Historically fire was one of the most influential disturbance processes in Missouri (Guyette and Cutter 1991, Guyette and Cutter 1997, Guyette and Dey 2000, Guyette et al. 2006, Stambaugh et al. 2006, Nelson 2010). Across the eastern, U.S. fire was an important disturbance process for millennia whether the ignition source was human caused and or by lightning (Wright and Bailey 1982, Nowacki and Abrams 2008). Fire regimes are crucial for the restoration and maintenance of prairie (Collins and Wallace 1990, Leach and Givnish 1996, Bowles et al. 2002), savanna (Anderson et al. 1994, Leach and Givnish 1999), woodland (Anderson and Schwegman 1991, Taft et al. 1995, Reburtus and Burns 1997, McCarty 1998, Batek et al. 1999, McCarty 2004, Rimer 2005), glade (Guyette and McGinnes 1982, Heikens 1999, Templeton et al. 2001), marsh (Weller 1994, Frost 2000) and fen (Bowles et al. 1996, Middleton 2002) communities. In addition to native grasslands, fire historically played a role in the structuring of many timbered communities across the Midwest (Guyette et al. 2006). Key terrestrial processes influenced by fire include (Wright and Bailey 1982): plant species composition and structure, nutrient cycling, thatch/litter depths, seed germination, and differential mortality based on species' physiological adaptations (e.g., thick bark to withstand heating).

Frequency, intensity, duration, extent and pattern variables of prescribed burn regimes will vary by community type and include restoration and maintenance activities. Different burn seasons have different ecological effects (McCarty 2004). Consult Nelson (2010) for details to determine desired conditions associated with various fire-adapted natural communities (prairies, savannas, glades, woodlands, fens, and marshes). In addition, fires also periodically burned in forest communities and through riparian zones. Fire was a pervasive influence on the presettlement landscape of Missouri (Schroeder 1981, Ladd 1991, Batek et al. 1999, Guyette and Dey 2000). It typically takes at least five burns before a site reaches maintenance objectives (McCarty 1998, 2004) assuming that vegetation structure and composition is close to desired conditions. Very few natural areas have reached the maintenance mode level of prescribed burning.

Prescribed fire and its corollary, wildland fire suppression, are complex management practices requiring adequately trained and experienced staff, advanced planning, specialized techniques, and considerable staff support and equipment. Firebreak preparation is critical as is having mobile water sources along firebreaks. Note that all prescribed burns require an approved burn plan and specially trained staff and equipment as per individual agency or landowner rules. The federal inter-agency National Wildfire Coordinating Group (NWCG) has developed rigorous standards and methods for wildland fire prescription and suppression activities (URL: http://www.nwcg.gov/). Private organizations and landowners should take prescribed fire training offered by MDC and the U.S. Department of Agriculture's NRCS. MDC is the lead agency for wildland fire suppression coordination in the state. All of the MoNAC partner organizations (MoDNR, MTNF, TNC, ONSR, USFWS) have their own policies and procedures relating to prescribed fire. A number of references are available that describe the basic logistics and steps involved with conducting prescribed fires (Wade 1989, Pauly 1997, Hartman 2005, Goodrich et al. 2008).

Smoke management, particularly when conducting prescribed fires near major roads and housing areas (the "urban interface"), can be a complex issue (Hardy et al. 2001). Local, state, and federal air quality laws can restrict prescribed fire ignitions. Currently the MoDNR Division of Environmental Quality, Air Pollution Control Program, does not regulate prescribed fire emissions. However, local municipalities often have open-burning regulations.

Guidelines:

- In general, prairies, savannas, and open woodlands require prescribed burns every 1-3 years and fens, marshes, glades, and closed woodlands require prescribed burns every 2-4 years to achieve management objectives (U.S. Forest Service 2005, Nelson 2010).
- Prescribed fires should be allowed to burn through forest natural communities and riparian zones.
- Season of burn should be varied when planning prescribed fire schedules. Besides spring burns, mix in summer, fall, and winter burns if possible.
- Vary ignition techniques depending on objectives, e.g., not every burn should be a ring head fire.
- As much as practical, firebreaks should utilize existing access lanes, roads, right of ways, and natural firebreaks (e.g., streams, wetlands).
- Use the minimum amount of firebreak necessary to achieve burn goals.
- Newly constructed firebreaks should be constructed such that soil disturbance is minimized and appropriate for the habitat that it is placed in.
- Disced firebreaks should only be used on degraded soils of buffer areas and not through intact soils of natural communities.
- Plow lines are only appropriate for wildland fire suppression. See the section on "Emergency and Wildfire Procedures on Natural Areas."
- Firebreaks should be oriented along the contour of the land whenever possible. Use caution when placing straight lines down steep slopes (15% +) to prevent erosion.
- To decrease erosion, water bars should be placed on any firebreak which has caused soil disturbance and is on a steep slope.
- Avoid creating firebreaks with fire plows or deep dozer blade depths.
- Do not place lines through sensitive features (e.g., fens, seeps).
- In general burn only 1/3 of a natural area's natural communities at any one time and or use patchy burns so as to leave insect refugia (Black et al. 2007).
- When burning in the fall or winter take care to ensure that adequate unburned or lightly burned vegetation or litter is remaining as buffer along riparian zones.
- Use care with ignition techniques around the entrance of air inflow caves.

Rare, Threatened, and Endangered Species Management

Background: Missouri Natural Areas support populations of more than 300 plant and animal species of conservation concern (Missouri Natural Heritage Database 2007). Natural areas are in a sense excellent genetic "libraries" of Missouri's native biological diversity. However, the primary management driver for rare, threatened, and endangered species should be restoration and maintenance of the habitat (natural communities) they require, including emulating historic disturbance processes to which these species are adapted.

Guidelines:

- Managing for natural communities should benefit most rare species but an analysis of life history needs for a species may indicate species-specific requirements (the "fine-filter" approach).
- Species reintroductions should be thoroughly evaluated. Seek MoNAC guidance (see section on Native Species Reintroductions and Augmentation Efforts).
  Surveys and monitoring are critical tools for effective management of rare species.

Silviculture

Background: Silviculture involves the art and science of manipulating the establishment, growth, composition, and quality of treed ecosystems for a specified set of resource objectives (Smith et al. 1996, Helms 1998). Typically, these objectives involve continuous timber production but, by definition,

other resource objectives can be targeted. The full suite of silvicultural tools involves everything from prescribed fire to planting trees. For these guidelines, we will limit the focus to the silvicultural practices of cutting, deadening or removing trees.

A general premise of ecological forestry is that silvicultural practices that more closely resemble relevant historic disturbance regimes and natural stand development processes are most likely to achieve ecological objectives (Kohm and Franklin 1997, Hunter 1999). However, silvicultural techniques do not precisely emulate outcomes of natural disturbances (Franklin et al. 2007) and caution must be used on natural areas. A variety of silvicultural techniques are available but the goal should be to create stand structure and composition as described by Nelson (2010) for savanna, woodland or forest communities. Silvicultural practices can range from cutting, or cutting and treating with appropriate herbicides, woody stems ranging from seedling size to mature trees. Silvicultural practices are often used in fire-adapted natural communities that have been fire suppressed for so long that removal of woody stems via fire alone is not logistically feasible. Thinning woody stems may also have a place in previously high-graded forest community sites to favor a certain species composition and hasten the development of old-growth structure. Silvicultural manipulations can create or accelerate the formation of some of the structural attributes of old-growth: produce large trees through crown release, create an irregular upper canopy, increase vertical structural diversity, create snags, mimic gap dynamics, and increase age diversity (Trombulak 1996, McGee et al. 1999, Mitchell et al. 2002, Keeton 2006). Most old growth characteristics prevail only with sufficient time, but in previously degraded stands, silvicultural manipulations can hasten the development of old-growth features.

Guidelines:

- In general, silvicultural practices such as cutting, deadening or removing trees are only appropriate on natural areas when the objective is improvement or maintenance of natural community composition and structure.
- Cutting of native or exotic shrubs and trees non-commercially to restore natural communities is a typical practice, especially for prairies, glades, savannas, woodlands, and fens. In many cases, a spot application of an appropriate herbicide is used to deaden the cut tree. Even in forests, understory and mid-story thinning may be employed to restore desired conditions.
- The production of a continuous supply of timber products is <u>not</u> an objective of silvicultural practices on natural areas. Natural areas are not a component of the "timber base."
- Deadening and or removal of woody stems commercially on an extensive basis will require MoNAC review except for prairie sites unless already approved in the natural area nomination's management recommendations.
- Silvicultural treatments will follow strict water quality best management practices (Missouri Department of Conservation 2006).
- Commercial timber harvest is a tool available for natural community management on natural areas, but it requires review by MoNAC. Any silvicultural practices on natural areas will require consistency with the natural area management recommendations approved by MoNAC in the official natural area designation document. The ecological need and justification must be communicated to MoNAC and followed up with an on-site review if requested. Monitoring and evaluation of silvicultural practices is required for all natural areas. In most cases, only one timber harvest entry will be needed for ecological restoration on a stand within a natural area. However, projecting out 80+ years into the future, the need may arise for additional timber harvest manipulations in a stand if prescribed fire treatments and non-commercial thinning are determined to not be completely meeting natural community management objectives. For any timber harvest, soils shall be dry or frozen and steps should be taken to minimize ruts from road traffic and vehicle use. Log landings shall be located outside of the natural area, unless

extenuating circumstances dictate otherwise. Any log landings within the natural area should be in buffer areas, seeded to non-contaminated annual wheat or rye and allowed to succeed back into native vegetation from on-site. Exposed soil may need to be covered with non-contaminated wheat straw and supplemental seeding of appropriate native species may be needed.

- Salvage timber sales where storm, insect/disease, or fire damaged/deadened trees are removed should only be done for safety reasons and or justifiable pest management needs. Seek MoNAC guidance for extensive (> 5 acres) salvage operations.

Stream Restoration and Management

Background: Streams on natural areas vary in their size, substrate, and flow regimes. Primary threats to aquatic natural communities include pollutants (excess sediments, nutrients, and toxins), altered hydrology, and non-native, invasive species (Richter et al. 1997). Sediment is the greatest water quality pollutant nation-wide and comes from a variety of human sources: poor construction practices, urbanization, poor row cropping practices, overgrazing, livestock access to streams, poor sand and gravel mining practices, channelization, loss of riparian vegetation, and poor logging practices (Turner 2008). High-quality streams have a hydrograph least impacted by dams, impoundments, channelization, levees, water diversions, and poor land management practices and land uses in the watershed (Master et al. 1998). Impervious cover (e.g., roads, buildings, parking lots) in the watershed should be under 10% (Wang et al. 2000) for aquatic system functioning. Thresholds for percent of the watershed in native vegetation to maintain aquatic ecological integrity have not been quantified (Sowa et al. 2004), but it can be assumed that the greater the amount of healthy, native vegetative cover in the watershed, the more ecologically intact a stream will be.

A stream is a product of its watershed (Leopold et al. 1964, Allan 2004) so restoring, protecting, and maintaining the ecological integrity of a stream natural community requires a watershed-scale approach and analysis (Hunsaker and Levine 1995, Sanders 2001). Base flow is stable and flood peaks of the hydrograph are moderate in high quality streams. Channelization, impoundments, watershed land uses, bridges, roads, ditches, and levees all can create stream vertical instability issues that can lead to bed degradation, head cutting, sedimentation, eutrophication, and eventual impacts to streams and associated riparian and wetland communities (MDC 2007). These off-natural area factors may impact streams on natural areas resulting in stream community degradation. Corrective streambank stabilization techniques or grade controls may be required to correct past or current problems in the stream or its watershed. However, determination of the need for stabilization techniques requires the input of hydrologists, fisheries biologists, stream ecologists, and civil engineers. Some streambank instability issues are mainly natural and should not be rectified with structures.

The MoDNR is the lead state agency involved with water quality issues; however, the MDC has authority over the fishes of Missouri, including fish kills from pollutants. The Missouri Clean Water Commission has the authority to carry out the public policy of Missouri to conserve waters of the state and to protect, maintain, and improve the quality of the waters of the state as per the Missouri Clean Water Law, including setting standards for water pollutants. The Missouri Clean Water Commission also designates "Outstanding State Resource Waters," high quality waters with a significant aesthetic, recreational or scientific value. A number of Missouri Natural Areas contain reaches of streams designated as Outstanding State Resource Waters. Other Missouri Natural Areas include portions of the Jacks Fork and Current Rivers both recognized as nationally significant streams that are part of the Ozark National Scenic Riverways.

Guidelines:

- Pursue designation of high-quality streams on Missouri Natural Areas as Outstanding State Resource Waters by the Clean Water Commission where appropriate.

- Learn the aquatic community stressors for the watershed in which the natural area stream occurs.
- Work with MDC fisheries biologists and MoDNR aquatic biologists to assess, monitor, and manage natural area streams.
- Livestock should be kept out of streams in general. A current exception has been made for bison and elk access to streams at Regal Tallgrass Prairie NA. Cattle access to prairie streams should be limited to first order streams without a tree canopy and an alternative water source should be provided (well or stock pond) as well as a shade source away from the streams.
- Do not channelize streams or levee floodplains.
- Do not allow sand or gravel mining.
- Avoid the use of heavy equipment in streams and along streambanks.
- Avoid installing bridges, fords, and low-water stream crossings in natural areas.
- Bridges within natural areas should be designed to minimize stream channel constriction and allow for some stream longitudinal migration (MDC 2007).
- Low-water stream crossings should utilize aquatic biota-friendly technologies that allow for passage of aquatic organisms up and down stream and do not create an impoundment effect upstream and a plunge pool downstream (MDC 2007, Novinger 2006). Only grade hardened crossings or open span bridges should be used.
- Seek to work with Missouri Stream Teams (URL: http://www.mostreamteam.org) and other watershed groups and policy makers to foster better watershed management practices that impact the natural area.
- Levees should be removed, set back, or notched as logistically feasible and appropriate. Remember coordination with the MoDNR, MDC, U.S. Army Corps of Engineers (COE), the NRCS and appropriate local entities (e.g., county, city, levee district) is needed ahead of time, including permitting.
- Channelized streams should be considered for restoration to a more natural channel design if appropriate. However, this work is highly technical (FISRWG 1998, Doll et al. 2003) and channelized streams typically will not be in a natural area.
- Bank stabilization can be used to impede artificially *accelerated* bank erosion via tree revetments, rock barbs or rock blankets as last-resort type projects. Seek the input of fisheries biologists, aquatic ecologists, hydrologists, and civil engineers. Remember coordination with the MoDNR, MDC, COE, the NRCS and appropriate county entities is needed ahead of time, including permitting.
- Grade control structures (e.g., rock check dams) can be used to stabilize a troublesome stream head cut. Seek the input of fisheries biologists, aquatic ecologists, hydrologists, and civil engineers. Remember coordination with the MoDNR, MDC, COE, the NRCS and appropriate local entities is needed ahead of time, including permitting.
- Logjams may be removed using best management practices after a review of the situation by fisheries biologists, aquatic ecologists, hydrologists, and civil engineers. Most logjams don't need removal. Remember coordination with the MoDNR, MDC, COE, the NRCS and appropriate local entities is needed ahead of time, including permitting.
- In-stream habitat work will usually not be needed on natural area streams, but see reference to grade control structures above.
- Removal of dams, impoundments, and flow-diversions may be a consideration on some natural area streams. Have the situation reviewed by a team of fisheries biologists, aquatic ecologists, hydrologists, and civil engineers.

<u>Traditional Fish and Wildlife Management</u>

Background: Natural areas are not managed for the sole objective of increasing fishing, hunting, or trapping opportunities. However, natural community management often increases populations of game

species as a by-product. For example, woodland management usually increases or maintains deer, turkey, and northern bobwhite habitat (Masters et al. 1996, Masters et al. 2001, Cram et al. 2002). On MDC, MTNF, and some ONSR owned and managed natural areas hunting and fishing is typically allowed under Missouri regulations and seasons. Trapping is allowed on MDC (via special use permit) and MTNF natural areas. Hunting and fishing are encouraged pursuits on most MDC and MTNF natural areas. Hunting and fishing are not typically allowed on TNC owned natural areas. Fishing is typically allowed on MoDNR natural areas but not hunting. However, MoDNR does conduct managed hunts to control overabundant deer populations when needed and validated by monitoring and assessment. The landowner decides whether a natural area is open to fishing, hunting, or trapping.

Guidelines:

- New game food plots or fishing ponds should not be constructed on natural areas.
- It would be preferred that grandfathered in existing food plots or fishing ponds be retired as practical (recognizing public use concerns).
- Existing food plots or fishing ponds should not be expanded in size.
- Existing game food plots should preferably use native Missouri plants but the use of non-invasive annual cereal grains (e.g, wheat), clovers (e.g., red clover, *Trifolium pratense*), grasses (e.g., orchard grass, *Dactylis glomerata*) and other plants may be used. When in doubt about a species' invasiveness, seek guidance from a botanist.
- Deer management on natural areas should strive to keep deer populations at levels that do not negatively impact plant communities.
- MoNAC guidance should be sought prior to any artificial stocking of game animals (including fishes) on natural areas.

Wetland Hydrologic Restoration and Management

Background: Hydrologic processes are instrumental to the development and functioning of wetlands (Cowardin et al. 1979, Carter 1996, Mitsch and Gosselink 1999). A wetland's water budget, the sources and quantities of inflows and outflows of water from a wetland, and the wetland hydroperiod (the seasonal and longer term patterns of inundation or saturation) have a dominant influence on the species composition of a site. Particularly important is the percent of the growing season that a site is inundated or saturated and the frequency, timing, and duration of flood events (McCarty et al. 2004, Heitmeyer et al. 2006). An analysis of flood frequency and duration by floodplain elevation is very helpful in determining riverine wetland restoration objectives.

Restoring some semblance of the presettlement hydroperiod is the goal of many wetland natural area management recommendations (McCarty 2005, Currier and Winfrey 2006). Most natural area wetlands are influenced by watersheds and or groundwater recharge areas not entirely owned by a conservation entity. Wetland restoration is often hindered by a lack of control of watershed land uses, including water uses and diversions.

For many wetland systems, the natural hydrology has been irreparably compromised and no true reference conditions exist, especially so in large river floodplains with highly human altered hydrographs (Galat et al. 1998). Natural area managers must understand that with big river wetlands the best that may be achieved will still not bring a site back to anything close to presettlement conditions. In these situations, we must settle for the best wetland hydrologic processes that can be obtained within the usually severe constraints on ecosystem management in larger floodplains (Heitmeyer and Westphall 2007). For some wetlands, only development of artificial water control structures (e.g., ditches, levees, berms, pumps, water collection and distribution systems, sediment

basins, stoplog or flap gate structures) will allow a more "natural" hydrograph to be achieved (Admiraal et al. 1997, Hammer 1997).

Excessive sedimentation is one of the largest threats to wetland and bottomland forest natural communities (Werner and Zedler 2002, Nelson 2010). Marshes, oxbows, sloughs, and wet prairies in floodplains with excessive sediment deposition may be considered for careful excavation of excess sediments by earth-moving equipment during drought conditions (Heitmeyer and Westphall 2007) as part of a well-developed restoration plan.

Restoration of groundwater seepage communities (e.g., fens) requires protecting an adequate well-vegetated buffer around the seepage outlets themselves as well as ensuring that the groundwater recharge area and the upslope watershed is primarily in native vegetation. Fortunately, groundwater seepage communities typically do not have sedimentation issues as found in many riverine and some sinkhole pond wetland sites. But groundwater recharge areas for fens can be larger than the immediate surface watershed. An understanding of hydrogeology is important in the delineation of groundwater recharge areas for fens and seeps (Amon et al. 2002, Locke et al. 2005). Alterations to groundwater quality and quantity can contribute to unwanted changes in natural communities that receive groundwater discharge (Panno et al. 1999).

Guidelines:

- Wetlands impacted by drainage ditches, drainage tile, roads, or cut off from sufficient water flow via levees should be restored by ditch plugs, check dams, tile cutting/blocking, culvert/road removal, and levee breaches as much as practical within legal, political, and socio-economic constraints.
- More natural water flow patterns, flooding regimes (both seasonal and decadal), and drainage regimes should be restored as practical.
- Natural community restoration and reconstruction projects should tie natural community types to floodplain landforms, soil types, and elevation-inundation zones based on an understanding of the interaction of these physical factors.
- Wetlands may be restored using water control structures, berms, and even water pumping only with a good understanding of the site's water budget, hydroperiod, soils, and topography. Seek MoNAC guidance for such projects.
- Wetland drawdown cycles should be based on more natural flooding regimes (i.e., based on historical hydrographs, long-term climate data, soils data, and wetland obligate species life history requirements) and not on waterfowl hunting demands or to maximize waterfowl production. Albeit, wetland natural areas do provide important habitat for migratory and breeding waterfowl and some do provide waterfowl hunting opportunities.
- To the degree possible and practical, wetland watersheds and recharge areas should be restored to native vegetation, particularly a healthy and abundant ground-flora layer of native sedges, grasses, and forbs that will slow erosion and runoff and enhance infiltration and groundwater recharge.
- Wetlands being dehydrated by down cutting and or head cutting streams should be restored by installing grade control structures in the degraded stream to prevent further bed degradation and water table lowering, if practical.
- Wetlands negatively impacted by channelized streams should be restored to the degree feasible by restoring stream channel sinuosity as practical.
- Wetlands threatened by excessive sedimentation may need silt management in the form of sediment basins, retention ponds, and or additional buffer lands to reduce the silt load coming

from upstream. Ideally, watershed land use best management practices would alleviate excessive silt load deposition in a wetland, but this is often not possible.

- Mechanical disturbances (especially soil disturbances) and chemical applications (except limited use of wetland-approved herbicides) should be avoided on or within a 200 foot radius buffer zone (Welsh 1991, Semlitsch and Bodie 2003, Mayer et al. 2005) around groundwater seepage natural communities (e.g., fens) and sinkhole ponds.

Public Use Guidelines

Background:
Most natural areas can support some amount of public use. MoNAC encourages and promotes appropriate public uses of natural areas, particularly educational and non-destructive scientific uses of natural areas. Public use facilities are kept primitive on natural areas and designed to blend into the landscape. Non-mechanized, dispersed, low-impact outdoor recreation such as hiking, bird watching, wildlife-watching, wildflower/native plant observation, and nature photography are well-suited for natural areas. Hunting, trapping, and fishing are allowed and appropriate recreational activities on many natural areas (state statutes and special regulations apply). Compatible and appropriate public uses for specific natural areas are guided by the laws, rules and mission of the landowning agency or organization or the desires of the private landowner as long as they are consistent with the general guidelines established here. Some natural areas contain extremely fragile natural communities such as caves and fens or species (such as hibernating bats) that are damaged by even low levels of visitation. Other natural areas are more resilient and capable of supporting moderate levels of public use. Visitation may be restricted on natural areas to specific areas such as trails or boardwalks, or areas may be closed at specific times of the year.

Public use must always be balanced with the goal of protecting the natural communities and rare or declining species contained within a natural area. The amount of public use of a natural area should be consistent with the fragility of the habitat and should not degrade the natural area resources. Natural areas make excellent outdoor classrooms for school and other educational groups to learn about natural history. Natural areas provide public access to significant remnants of the original landscape that greeted early explorers and settlers.

Amount of use, density of use, type of use, and user behavior are the key components to consider in assessing the impact of public use on a natural area. All outdoor recreation, from bird watching to horseback riding, impact to natural resources to some extent (Hammitt and Cole 1998, Taylor and Knight 2003). However, in general, the impacts from hiking, bird watching, nature study, botanizing, photography, and regulated hunting and fishing tend to have minimal negative impacts to natural resources if done in a planned fashion that avoids sensitive sites. With all outdoor recreation uses of natural areas, "Leave No Trace" principles and practices (see URL: http://www.lnt.org) should be promoted to area users. Impacts of public use can include trampling of vegetation, soil erosion and compaction, disruption of animal populations, user group conflicts, hastened erosion of geologic features, human waste issues, littering, vandalism, direct take of plants and animals (including harvest), and introduction of invasive species. Off-road and off-highway vehicle use (e.g., all-terrain vehicles or ATVs) for recreation causes significant environmental impacts (Webb et al. 1978, Webb and Wilshire 1983, Marion 2006) and is therefore prohibited as a public use on designated natural areas, the only exception being retrieval of harvested deer or emergency rescue under some circumstances.

Monitoring and assessment of public use patterns and impacts is important to maintain natural area ecological integrity. A "Limits-of-Acceptable Change" (LAC) planning and management framework for outdoor recreation impacts (Stankey et al. 1985) is a good approach for natural area managers to use

in managing natural area public use. Under this framework, numerical, realistic standards can be set for various indicators in accordance with statements defining desired resource and social conditions (e.g., vegetation trampling at a campsite should be limited to less than a quarter acre). The LAC framework allows limits to be set between acceptable and unacceptable resource conditions to compare against a measureable baseline. Visitor impact monitoring provides the information needed for decision making on public use regulations to keep resource impacts below a threshold of resource degradation from outdoor recreation activities. The U.S. Forest Service uses the LAC framework for federal wilderness area management and the National Park Service has adopted a similar framework for backcountry recreation.

Guidelines:

Normally appropriate public uses of natural areas: animal observations, bird watching, botanical observations, environmental education and interpretation, fishing, geological observations, hiking, hunting (except on MoDNR and TNC lands), nature photography, nature viewing, natural history observations, scientific research and monitoring, stream observations, walking, wildflower viewing, and wildlife watching.

Conditionally appropriate (permitted on some natural areas but not all) public uses of natural areas: biking, boating, caving, geocaching, horseback riding, picnicking, primitive camping, swimming and trapping.

Incompatible public uses of natural areas (note this list is incomplete and not comprehensive): collection of plants, animals, minerals, or artifacts; field trials, jet skis, off-road vehicles, off-trail horseback riding or biking (except on MTNF lands), paint balling, rock climbing or rappelling, scuba diving, and unleashed pets (other than hunting dogs used for hunting and service dogs).

The section below alphabetically lists and discusses the appropriateness of specific public uses of natural areas.

<u>Bike Riding</u>
Bikes are only allowed on designated trails (except on MTNF lands). Please see the discussion and guidelines under "Trails" below.

<u>Boating</u>
The use of canoes and kayaks on streams and wetlands is typically appropriate under light to moderate use. Gasoline powered motor boats are discouraged on natural area waters and are illegal in some cases. Electric powered motor boats are typically appropriate on natural area streams of sufficient size. Motor boat horsepower restrictions may be needed on stream natural areas for ecological and noise pollution reasons. For example, the ONSR has horsepower limitations along sections of the Jacks Fork and Current Rivers that impact designated natural areas. Gasoline powered boats can create issues of stream contamination with petroleum, noise pollution, and excessive wave action (wake) impacts to aquatic life and shoreline stability (Asplund 2000). Further guidance:

- Natural areas on rivers where motorboats are permitted would benefit from horsepower regulations.
- No wake zones may need to be designated for streams and wetlands on natural areas.
- Gas powered motorboats are discouraged on natural areas.

- Watercraft should be cleaned when transported from other waters to natural area waters using guidelines developed to prevent the spread of zebra mussels (see URL: http://www.mdc.mo.gov and search under "zebra mussels").

Camping and Picnicking

Developed campgrounds and picnic grounds are not allowed on natural areas. However, undeveloped or primitive camping is allowed on some natural areas. The rule is pack-out what you pack-in in terms of trash. Primitive camping can negatively affect natural resources, including loss of vegetation, erosion of organic litter, soil exposure, erosion, and compaction; exposure of tree roots, and damage to tree trunks (Hammitt and Cole 1998). In addition, littering and human waste can threaten water quality and human health (McEwen and Cole 1997). For example, Shenandoah National Park originally allowed at-large backcountry camping, but due to increased impacts to natural resources, the park in 2000 revised their backcountry camping policy and restricted visitors to only well-established campsites in the backcountry. This reduced natural resource impacts park-wide (Reid and Marion 2004) as overall visitor use was increasing. Whether primitive camping is allowed or not varies on a case by case basis. Some large upland natural areas allow primitive (walk-in/backpacking) camping on either a designated campsite or at-large camping basis. Natural areas would benefit from a permit system to limit impacts of group camping (ten or more campers).

Caving

Caving is a special form of public use that can have significant detrimental impacts to cave natural communities if unregulated (Hildreth-Werker and Werker 2006). See the section earlier on Cave and Spring Restoration and Management for details on cave use by the public, the rationale for cave protection, and management guidelines regarding caving. Cave use should be regulated by the degree of potential impact to significant biological, geological, archaeological, and paleoecological resources found in a specific cave. Significant caves often are gated with specialized gates that provide appropriate airflow and bat ingress/egress but protect cave resources from unscheduled public use. A permitting system for public cave use is recommended.

Collecting Plants, Animals, Minerals, and Artifacts

Collection of plants, animals, minerals, and artifacts is typically inappropriate on natural areas. However, nuts, berries, fruits, and mushrooms may be taken for personal consumption on natural areas unless further regulated by the natural area owner. Research collecting of plants, animals, minerals, and artifacts is covered under the section on Research and Collecting Criteria. Collecting is often a needed and valuable practice for research and monitoring.

Geocaching

Geocaching is an orienteering-type game for GPS (Global Positioning Systems) users (see URL http:// www.geocaching.com). Geocaching has become very popular with some of the public in recent years. Another related type of outdoor orienteering game is letterboxing. Both geocaching and letterboxing typically involve leaving something in the field for someone to find. However, some geocachers do not deposit a cache but merely locate a particular natural object or view. Different MoNAC agencies have different policies regarding geocaching. Currently MoDNR, MDC, and MTNF allow geocaching via a permit system. ONSR, USFWS, and TNC currently prohibit traditional geocaching. MoDNR and MDC have policies to allow for geocaching via permits at the discretion of the area manager. General guidelines regarding the placement of caches include not disturbing the soil, rocks or vegetation; avoiding prescribed burn units, and avoiding sensitive archaeological, historical or ecological areas. In general, geocaching on natural areas should be minimized and some natural areas are not appropriate for geocaching.

Group Uses

It is recommended that groups of greater than ten people wanting to camp, hike, horseback ride, bike or visit sensitive habitats should get permission from the natural area manager.

Horseback Riding

Horseback riding, where permitted, is typically restricted to designated trails (except on MTNF lands). Please see the discussion and guidelines under "Trails" below.

Hunting and Fishing

Hunting is recognized as a valid recreational use on almost all rural natural areas owned and managed by MDC, MTNF, and ONSR. On MoDNR and TNC natural areas, hunting is not allowed except for managed deer hunts aimed specifically at culling overabundant deer populations that have caused ecological damage. Natural areas owned by other entities vary on their hunting regulations. The decision to allow hunting on a natural area is determined by the landowner. Hunting follows regulations of the Wildlife Code of Missouri. Hunting within regulations typically is compatible with the maintenance of ecological integrity on natural areas. Hunting restrictions are typically based on the need to reduce user group conflicts and depend on the primary mission of the natural area ownership.

Fishing is recognized as a valid recreational use on most publicly owned natural areas. Fishing is prohibited on some publicly owned natural areas to prevent take of rare or declining fish species. Fishing can create unintended negative ecologic impacts when non-native live bait species are accidentally or purposefully dumped into streams. Dumping live bait into public waters is illegal in Missouri if they are not obtained from the same waters. Certain exotic species cannot be used as live bait (Missouri Wildlife Code). Bank fishing sometimes can create heavily used unauthorized trails that can create bank erosion issues. The decision to have a natural area open to fishing is determined by the landowner. Hunting and fishing regulations are set by MDC for sustainable harvest levels based on the best data available.

Additional considerations:

- Lead shot should not be used for hunting in wetland natural area situations due to environmental contamination issues.
- The import of fishes and crayfishes as live bait in natural areas is discouraged.

Off-Highway/Road Vehicles (ORVs) and All-Terrain Vehicles (ATVs)

Recreational ORV and or ATV use is prohibited on natural areas. The only exception might be retrieval of a harvested deer by a hunter under special circumstances or emergency rescue. Ample evidence exists that ORVs and ATVs can cause accelerated soil erosion or compaction and excessive vegetation damage; greatly facilitate the spread of invasive, exotic plant species; and produce unacceptable levels of noise pollution (Webb et al. 1978, Webb and Wilshire 1983, Kuss et al. 1990). Well-designed ORV or ATV trails require substantial investments to build and maintain for a recreational use not well aligned with the goals of the Missouri Natural Areas Program.

Parking Lots

Parking lots and kiosks are constructed on natural areas but must be installed in non-sensitive areas, preferably at the margins of the natural area and on buffer lands. Consult with the respective agency's natural areas committee for guidance on installing new parking lots. Cultural artifact and Missouri Natural Heritage Database assessments are recommended prior to construction.

Pets

Pet dogs are allowed on natural areas. It is recommended that they be leashed especially on developed trails and public use areas. Hunting dogs are allowed to assist with small-game hunts (as per the Missouri Wildlife Code) for those natural areas open to hunting. No "field trials" with dogs are allowed. Unleased dogs during the growing season can have detrimental impacts to wildlife, especially ground nesting birds (Miller et al. 1998).

Rock Climbing and Rappelling

Rock climbing and rappelling are prohibited on natural areas because of the well-documented potential for negative impacts to plant and animal species of cliff faces, cliff ledges, and talus slopes from these activities (Nuzzo 1996).

Scuba Diving

Scuba diving is not appropriate on natural areas except for research purposes due to public safety issues and also the fragility of some aquatic natural communities (e.g., springs). Scuba diving requires a special use permit and certification.

Signage

Interpretive and regulatory signage is typically deployed on natural area trails and should convey the appropriate message without being overly intrusive to the more undeveloped nature of the area. It is recommended that natural area boundary signs be posted at typical public access entry points to natural areas to let area users know of the special area they are entering. Natural area boundary signs might also be posted every 300 ft. along land ownership boundaries that coincide with a natural area boundary and along natural area boundaries that follow roadways. The sign shops of MoDNR and MDC produce standard MoNAC boundary signs.

Swimming

This typically does not cause adverse ecological impacts to streams if users are dispersed and infrequent. However, springs and sinkhole ponds can be easily damaged by swimmers. There are public safety issues with swimming on natural areas too. Swimming is not encouraged on natural areas.

Trails

Developed trails are often created on natural areas to allow for appropriate public use. Trails should be designed to be sustainable. Sustainable trails are those that (National Park Service, Rocky Mountain Region, January 1991): support current and future use with minimal impact to the area's natural systems; produce negligible soil loss or movement; recognize that pruning or vegetation removal will be necessary for trail maintenance; do not adversely impact the area's wildlife; accommodate existing uses while allowing only appropriate future uses; and require little rerouting and minimal long-term maintenance. Yet, all trails – even well-designed and constructed foot trails – have some negative impacts on natural resources (Hickman 1990, Benninger-Truax et al. 1992, Adkison and Jackson 1996, Miller et al. 1998, Parendes and Jones 2000). These impacts include some degree of soil alteration (compaction and erosion), an increase in invasive native and non-native plant species populations, and disruption to native animals, such as breeding bird populations. Summer (1980) identified the most influential landscape factors governing trail deterioration as parent material, grade of trail and side-slope, soil texture and organic content, rockiness, vegetation, and drainage. Natural area managers considering building new trails or evaluating existing trails should consider these key questions: Why do we need this trail? Who will use the trail? What kind of visitor experience are we trying to create? Who will maintain the trail and how much maintenance is needed?

In general, of trail users, horseback riding creates the greatest environmental impact compared to hikers and mountain bikers. Horseback riding on trails creates more erosion and soil compaction than hiking (Weaver and Dale 1978, Whittaker 1978, Summer 1980, DeLuca et al. 1998, Marion 2006). For example, unshod horses exert a ground pressure of 18 pounds per square inch and shod horses exert a ground pressure of 62 pounds per square inch compared to 2.9 pounds per square inch for a hiker in boots (Liddle 1997). A study by Stroh and Struckhoff (2009) on the ONSR indicated that horse trails facilitate unintentional introduction of exotic plant species, including invasive ones. They recommended redirecting existing horse trails away from, and planning for new horse trails to avoid, high quality natural community sites. Campbell and Gibson (2001) found more exotic species along trails that allowed horse travel than those on trails lacking horse use. Horse use of trails can also create user group conflicts (Watson et al. 1993). For the above reasons, new horseback riding trail development in natural areas is not allowed. Study results are mixed when comparing hiking to mountain biking in terms of environmental impacts (Thurston and Reader 2001). There is evidence that mountain biking is somewhat more environmentally damaging than hiking but they are similar in impacts and both pale in comparison to the impacts of horseback riding (Morlock et al. 2006, Marion and Wimpey 2007).

Providing public access and appreciation of natural areas while protecting their sensitive natural features often requires "hardening" trails and access points. For example, trails to access wetlands typically involve wooden or metal boardwalks, e.g., the hiking trails at Big Oak Tree NA and Coakley Hollow Fen NA. Other sites feature overlooks to better gain a view such as at Little Bean Marsh NA. In other situations even paved trails or significant stonework is employed to protect a natural feature, such as at Big Spring NA and Ha Ha Tonka Karst NA. Further considerations:

- New horse and or bike trails are not allowed on natural areas. However, short re-routes of existing horse or bike trails are allowed as needed to avoid resource damage. Pre-existing horse and bike trails are grandfathered in for new natural area nominations as determined during the nomination process.
- Existing trails on natural areas should be maintained to avoid excessive soil erosion, trail widening, and rutting.
- All trails that are creating clear and significant detrimental impacts to high-quality natural communities and or species of conservation concern (Missouri Natural Heritage Program 2010) should be closed and or re-routed.
- Significant new hiking trail construction should be reviewed by MoNAC and appropriate agency trail experts.
- New trail routes should be reviewed against the Missouri Natural Heritage Database to avoid negative impacts to species of conservation concern and trail impacts to archaeological resources should be considered as well.
- To limit the impacts of recreational use, trails need to be designed well, annually inspected, and maintained.
- Trails should be inventoried and mapped with a GPS unit and overlaid on topographic maps to provide better trail maps for the public and for better trail maintenance planning and conservation assessments.
- Trails should avoid sensitive features whenever possible, including cave entrances, groundwater seepage communities (e.g., fens), marshes, easily eroded geological features (e.g., sandstone outcrops), glades, spring runs, and rare species sites.
- Trail creek crossings should be minimized. For natural areas with high-quality aquatic natural communities span bridge crossings are recommended.
- Horse and bike trails in riparian corridors with multiple (> 2) creek crossings should be considered for closure or re-routing.

- Sustainable trails should: keep water off the tread and users on it; build on the contour (side slopes) and use frequent grade reversals; keep trail grade below half the grade of the sideslope; keep maximum grade <15%; have an average grade under 10%; route trails to positive control points (e.g., overlooks); use bench-cut construction; avoid the shortest route down a hill ("fall line"); avoid flat areas (unless using boardwalks or berms); outslope trail tread; incorporate grade reversals for drainage; and armor creek crossings and sensitive features. See the U.S. Department of Transportation's Recreational Trails Program website (URL: http://www.fhwa.dot.gov/environment/rectrails) and publications by IMBA (2004) and Hesselbarth et al. (2007) for excellent trail planning, design, construction, and maintenance information.
- Be especially careful when designing or maintaining stream crossings (ephemeral, intermittent, and perennial streams). Armored creek crossings, culverts, and bridges are all techniques to cross streams, but culverts have the highest potential to damage streams. See IMBA (2004) and Hesselbarth et al. (2007) for guidance. Span bridge crossings are recommended for natural areas with high-quality aquatic natural communities.
- In general, trails should avoid crossing wetland features. However, there are cases where trails must cross a wetland or the wetland is of interpretive value and the trail will highlight this. Wetland trails include raised tread or boardwalk construction. Boardwalk construction is preferred as it interferes less with water flow. See Steinholz and Vachowski (2007) for guidance on wetland trail design and construction.
- Horse trail maintenance and re-routing should follow the Missouri *Equestrian Trail Guidelines for Construction and Maintenance* by Tabor et al. (2007).

Trapping

Trapping of furbearers (e.g., beavers) is permitted on MDC (via special use permit), MTNF, and privately owned designated natural areas.

Emergency and Wildfire Procedures on Natural Areas

In emergency situations that require immediate action to prevent injury to persons or unacceptable damage to property, the guidelines established here for natural area management are put aside as necessary to alleviate the emergency situation. However, it is expected that emergency actions attempt to cause as minimal damage to natural conditions as dictated by the situation. Use of heavy equipment and motor vehicles off established roads and trails should be avoided if practical.

All wildfires should be brought under control as quickly as possible using the least intrusive suppression techniques available based on the value-at-risk from the wildfire, adjacent fuel types, and current fire danger conditions (U.S. Forest Service 2005). When the value-at-risk (e.g., structures nearby is a high value-at-risk) from the wildfire is low and fire danger and intensity levels are low, suppression actions should be low impact, such as allowing the fire to burn to a natural or manmade fuel break or putting in a hand line. When the value-at-risk is medium or greater and or the fire danger conditions are medium to high then mechanical construction of firebreaks using heavy equipment is warranted. Dozer line construction of firebreaks in natural areas should be avoided whenever possible. Dozer blade lines are preferred to dozer plow lines when constructing firebreaks. Mechanically constructed firebreaks should avoid cave entrances, riparian areas, wetlands, glades, and known rare species sites whenever possible. Post-fire erosion control and revegetation should follow best management practices (Missouri Department of Conservation 2006). Mulch should be weed-free straw and only non-invasive annual grasses (wheat, rye) or native species appropriate to the site should be used.

Research and Collecting Criteria

Research opportunities are abundant on designated natural areas. Research is construed here broadly as any of a number of different types of scientific inquiries, from qualitative observations to more quantitative designs. Baseline inventories such as surveys of the distribution and abundance of plant and animal species are extremely valuable. Status and trend studies of the biota and physical environment of natural areas are encouraged. Scientific studies of natural areas include many disciplines. MoNAC wishes to further scientific research within state natural areas and to cooperate with professional and technical workers as tempered by the need to protect the integrity of natural communities, their component species, and other features of designated natural areas. Manipulative research studies, including collecting, require a permit issued by the administering agency.

Different agencies have different research and collecting permits. Most permits will typically contain certain information that the applicant must provide: contact information of the applicant, names of the researchers, qualifications of the researchers, proposed natural area(s) for research, description of the project, including the objective(s), methods, and procedures; duration of the project, types of equipment to be used, sites to be visited, beginning/ending dates, frequency and length of visits, description of species or objects to be collected, method of taking, and disposition of specimens; potential disturbances and impacts and mitigation strategies, and anticipated reports/publications.

Collection of species listed as endangered under the Missouri Wildlife Code will require permission from the MDC. Collection of species listed as threatened or endangered under the U.S. Endangered Species Act will require permission from the USFWS. Migratory bird collection requires a permit from the USFWS. Collection of vertebrate animals, mollusks, or crayfishes requires a wildlife collector's permit from MDC. Invertebrates listed as Missouri Species of Conservation Concern by MDC (Missouri Natural Heritage Program 2010) also require an MDC wildlife collector's permit. It is good practice to require researchers to contact the area manager and or law enforcement personnel (e.g., park ranger, conservation agent) prior to beginning the project activities. Collection of archaeological and historic artifacts will require input from the Missouri State Historic Preservation Office.

Research on natural areas should be conducted such that the area's natural features are not degraded. All collections should be used for scientific or educational purposes only and not for profit. It is suggested that specimens be deposited in institutions for permanently maintaining specimens of Missouri's flora and fauna (e.g., the Missouri Botanical Garden herbarium). Reports of research conducted on natural areas should be sent back to the administering agency and, ideally, a copy also provided for the natural areas master files kept by MDC. Duplicate files are maintained by the Missouri Department of Natural Resources.

Natural Area Inventory and Monitoring Guidelines

Inventory

Background: The first step of any work on natural area designation or management involves taking an inventory (or evaluation) of the natural communities of a region to decide which ones qualify for natural area designation. Natural area inventories answer the basic questions of what high quality natural community sites do we have and where are they? A number of studies of Missouri's flora, fauna, and geology documented natural features sites of Missouri, such as Steyermark's work towards the *Flora of Missouri* (1963), before the formal concept of designated Missouri natural areas existed. Formal surveys to locate natural features of biological or geological significance in Missouri began in the mid-

1960s with Bill Elder of the University of Missouri-Columbia. Bill Elder and his graduate students continued natural area inventories through the 1970s (e.g., Karel and Elder 1976) and by 1979 every county in Missouri had been investigated to some degree for potential natural area sites (Pryor 1980). These first surveys for natural area sites evolved with the concept and definition of a Missouri "natural area" and relied mainly on compiling existing information to identify natural area sites. The first Missouri Natural Area designations began in 1971 after the Missouri Conservation Commission endorsed a natural areas system for MDC lands. The inter-agency Missouri Natural Areas Committee was created in 1977 with an agreement between MoDNR and MDC which lead to further inventories to locate areas on public and private lands of natural area quality. Aquatic and terrestrial natural community classification systems were published in 1978 for use by MoNAC to further natural area inventories.

In neighboring Illinois, a pioneering natural areas inventory was completed in 1978 (White 1978). The Illinois Natural Areas Inventory developed a system of natural community classification and natural features inventory techniques that highly influenced the development of Missouri's developing natural areas program. At the same time The Nature Conservancy was developing its natural heritage program methodology under the leadership of Bob Jenkins, then vice-president for science within TNC (Jenkins 1988). A description of natural heritage program methodology for inventory and tracking of rare plant and animal species and natural communities is described in Stein and Davis (2000) and on the website of NatureServe (URL: http://www.natureserve.org), the organization that represents the network of state natural heritage programs. The Missouri Natural Heritage Program began in Missouri, first within MoDNR (1981), then within MDC starting in 1983 (Butler 2009). The Missouri Natural Heritage Database has been used by the Missouri Natural Areas Program for over twenty years as the primary source of data on rare species and high-quality natural communities of the state. Today the Database is housed within the Missouri Department of Conservation (URL: http://mdc.mo.gov).

From 1981 – 2001 various biologists hired by MDC and funded from a variety of sources conducted systematic county-by-county inventories (known as the Missouri Natural Features Inventory) state-wide for rare and declining species, high quality natural community sites, and significant geological features (e.g., Currier 1991). The basic methodology of these inventories was that developed originally by the Illinois Natural Areas Inventory and the data were stored and managed using the methods of the natural heritage program network alluded to above. Detailed descriptions of inventory methods for terrestrial natural communities are found in Appendix B. One of the salient limitations of the Missouri Natural Features Inventory was that it focused primarily on terrestrial species and natural communities emphasizing plants (Leahy 2006). Separate efforts have been made regarding inventories of cave natural features (Bretz 1956, Gardner 1986, Elliott 2007).

The designation of natural areas and the Missouri Natural Features Inventory were assisted greatly by the publication of *The Natural Divisions of Missouri* by Rick Thom and Jim H. Wilson (1980), *The Terrestrial Natural Communities of Missouri* by Paul Nelson in 1985, the *Aquatic Community Classification System for Missouri* by Bill Pflieger in 1989, and the *Geologic Natural Features Classification System for Missouri* by Arthur Hebrank (1989). Field data collected by the Missouri Natural Features Inventory were stored in the Missouri Natural Heritage Database as part of the Missouri Natural Heritage Program. Conservation planning efforts then used these data to generate lists of sites to acquire, conserve, protect, and restore with an aim towards natural area designation (Gremaud 1991). Different MoNAC agencies also had internal inventory programs that looked at their ownerships at a finer scale for rare and declining species and high quality natural communities. During the 1970s through the 1990s, a number of graduate student projects focused on natural community identification in Missouri (e.g., Orzell 1983) that provided information to MoNAC on suitable sites for natural area designation.

Since 2001, natural area inventory efforts have been more diffuse and have built upon the gains in knowledge in conservation biology over the last 20 years and the increasing use of geographic information system (GIS) technologies. New, significant conservation sites worthy of natural area designation continue to be discovered either through inventory or the process of restoration of degraded natural communities. New discoveries of Missouri's flora and fauna continue to occur every year and the process of inventory for sites of natural area quality has not been completed. For example, stream and cave natural communities are still underrepresented within the Missouri Natural Areas System at this time.

In recent years, the development of the Missouri Ecological Classification System (ECS) has refined the thinking of the inventory process for both terrestrial (Nigh and Schroeder 2002) and aquatic (Sowa et al. 2007) natural communities by providing a more detailed biogeographic basis for natural area inventory and management. The Nature Conservancy began ecoregional conservation planning efforts in Missouri in the 1990s that resulted in ecoregional assessments covering the four major biogeographic regions of Missouri, such as the Ozarks (The Nature Conservancy 2003). These planning efforts identified key sites and landscapes for natural areas conservation and broader conservation biology goals. In 2005, a significant revision of the *Terrestrial Natural Communities of Missouri* by Paul Nelson was published by MoNAC that has provided a modern synthesis of natural community information in Missouri gleaned from over 30 years of natural area inventory, restoration, and management (the 4th edition came out in 2010). In the same year, Missouri completed the Missouri Comprehensive Wildlife Strategy (Figg and Linsenbardt 2005) for the USFWS that utilized state-of-the-art conservation planning techniques (Groves 2003) to identify "conservation opportunity areas" or landscapes in Missouri that would be the best places to go to work for conservation. Since the first Missouri natural area designation in 1971, the art and science of natural areas inventory has evolved considerably.

Currently, a number of biological surveys from university studies to agency projects provide information to the Missouri Natural Heritage Database and indirectly aid in the identification of potential new sites for natural area designation. It is beyond the scope of this manual to identify all of the different biological and ecological inventories currently being conducted in Missouri that can or do provide data useful to furthering the goal of identifying potential natural area sites. Suffice it to say that the work of natural area inventory is not done.

Guidelines:

- High-quality or the best remaining examples of natural communities are the primary basis of natural area designations.
- Consult the Missouri Natural Heritage Database, Missouri Natural Feature Inventory reports, TNC ecoregional plans, and the Missouri Comprehensive Wildlife Strategy for places to evaluate for natural area status.
- Consult Elliott (2007) for an analysis of Missouri cave zoogeography and biodiversity, including a ranking of caves for conservation planning (potential natural area sites). The Missouri Speleological Society maintains a Missouri Cave Database (House 2008) that can provide information on caves for natural area nominations.
- The Missouri Resource Assessment Partnership (MoRAP) has developed human stressor index values for all the aquatic ecological systems in Missouri (Annis et al. 2005) and is currently completing human stressor index values for every Missouri stream reach contained in the 1:100,000 national hydrography dataset (URL: http://www.cerc.usgs.gov/morap/). These data provide a good starting place to identify stream reaches to evaluate for aquatic natural area status.

- Many high-quality waters have been designated as State Outstanding Resource Waters by the Missouri Clean Water Commission and these can provide a source of sites to evaluate for aquatic natural area status.
- Work with ecologists, taxonomists, soil scientists, and geologists to identify potential natural area sites.
- Use natural community descriptions in Nelson (2010) and Pflieger (1989) to guide inventory efforts and evaluation of natural community sites for natural area status.
- Utilize methods developed by the Missouri Natural Features Inventory to inventory, evaluate, and assess terrestrial (except caves) natural communities for their ecological integrity (see Appendix B) and natural area potential.
- Terrestrial natural community (except caves) inventories for natural area consideration should include measurements or descriptions of: vegetation structure (e.g., tree age classes, woody cover by vertical strata), vegetation composition (e.g., dominant, characteristic, and rare species), disturbance regime histories (e.g., fire history), negative human disturbances (e.g., overgrazing, indiscriminant logging), and physical site conditions (e.g., soils, geologic formations, landforms). A map of the extent of the natural communities overlaid on a U.S. Geological Survey 7.5' topographic quadrangle base should be done. Additional information on herptiles, insects, small mammals, and breeding birds is recommended for terrestrial natural community evaluations as time permits. Vegetation is used as a crude surrogate for assessing the diversity of insects – studies indicate that a vegetation-based natural community evaluation approach can contribute to the conservation of insect biodiversity in the midwest (Panzer and Schwartz 1998).
- Utilize the concept of "conservative" or "remnant-dependent" plant species when evaluating the vegetation composition component of natural communities for natural area consideration. For example, if somebody brings a botanist a specimen of common ragweed (*Ambrosia artemisiifolia*) the botanist will have no idea where this plant came from – it could have come from a high-quality prairie or somebody's back yard. Plants such as common ragweed are assigned a low "coefficient of conservatism" value, a zero on a scale up to 10. On the other hand if somebody brings a botanist a specimen of the prairie grass pink orchid (*Calopogon oklahomensis*) the botanist will know that this plant came most likely (>80% chance) from a remnant prairie. Prairie grass pink orchid is assigned a "coefficient of conservatism" value of 10 – prairie grass pink orchid is a "conservative" species. A floristic quality assessment approach using this concept of conservative species is recommended for assessing the ecological integrity of terrestrial natural communities (Swink and Wilhelm 1994, Taft et al. 1997, Lopez and Fennessy 2002, Taft et al. 2006). Ladd (1996, 1997) has created a list of "coefficients of conservatism" for Missouri's vascular plant species to use in natural area inventories. This list is currently being revised and updated to parallel taxonomic and nomenclatural changes to Missouri's vascular flora.
- Cave natural community inventories for natural area consideration should include measurements or descriptions of a cave's: faunal composition (including invertebrates), particularly for troglobites; geological features, microhabitat patterns (e.g., drip pools), and negative human disturbances (e.g., vandalism of speleothems). A cave map should be completed using National Speleological Society cave cartography conventions. Additional useful information include: projections of the footprint of the cave onto above-ground topographic maps, delineation of the cave recharge zone, temperature and humidity profiles of the cave, and water chemistry of cave waters.
- Aquatic natural community inventories for natural area consideration should include measurements or descriptions of the fish fauna, stream discharge, stream order, channel morphology, channel substrates, stream hydrograph, mean stream temperature (cold versus warm-water fishery), watershed size and land uses, riparian zone vegetation, instream habitat

features (e.g. riffles, rootwads) and negative human disturbances (e.g., poor watershed land use practices). A map of the stream reach, spring, or overflow waters (e.g., oxbow lake) overlaid on a U.S. Geological Survey 7.5' topographic quadrangle base should be done. Additional information on mussels, crayfishes, and other benthic macroinvertebrates (especially stoneflies, mayflies, and caddisflies) is recommended for aquatic natural community evaluations. Using multi-metric indices of biological (or ecological) integrity can be a useful tool in evaluating aquatic natural communities (Karr 1991, Illinois Department of Natural Resources 2008). Indices of biological integrity (IBI) have been developed for Missouri Ozark stream fish communities (Doisy et al. 2008) and Missouri benthic macroinvertebrates (Rabeni et al. 1997, Sarver et al. 2002). Water chemistry data (e.g., dissolved oxygen, pH, water temperature, conductivity, nitrate and phosphate levels, and turbidity) are also useful in evaluating the quality of an aquatic natural community.

- Descriptions of geologic features should follow methods outlined in Hebrank (1989).
- Species lists should be developed as time allows for all designated natural areas. Voucher specimens should be deposited in appropriate museums or herbaria.
- Natural community descriptions and maps and rare species locations and demographics should be recorded and the data transferred to the Missouri Natural Heritage Database.

Monitoring

Background: There are a variety of definitions of biological monitoring (Elzinga et al. 2001). For the purposes here monitoring will be defined as by Salzer and Salafsky (2006) as: "the process of periodically collecting and using data to inform [natural area] management decisions." Monitoring should have objectives and management implications. Natural areas monitoring should focus on answering the question "are we conserving what we say we are?" A key decision is how much to invest in taking action versus monitoring. Natural area managers need to balance the need to do restoration efforts such as prescribed burning against how much time to spend monitoring the results of these management actions. Some level of status report monitoring is needed for all Missouri Natural Areas. At the very least, natural area managers need to walk through the natural area once a year to check for the presence and damage from invasive species, vandalism damages, natural disturbances, and overall integrity of the site. Annual natural area status reports are a minimum investment in monitoring the status and management effectiveness at these sites.

Beyond a general annual natural area status report, natural area practitioners need to decide how much to invest in monitoring efforts. Salzer and Salafsky (2006) provide an excellent decision tree to help best allocate limited resources for monitoring. Monitoring is directly related to the concept of "adaptive management" whereby monitoring is used to measure success at meeting a management objective and to refine or change management practices if needed (Williams et al. 2007, Lyons et al. 2008). Adaptive management is an iterative learning process, a type of structured decision making, and provides a useful framework for natural area practitioners.

Typically, monitoring involves detecting differences in a species or natural community metric among locations at a given moment (status) or changes in metric values across time at a given spot (trend). The Missouri Natural Heritage Program provides a methodology and database to do this for natural communities and species of conservation concern – it is the primary tool for measuring status and trends of Missouri's threatened native biological diversity. A wide variety of local, regional, state, and national level biological monitoring efforts exist. For example, The National Park Service has an Inventory and Monitoring Program that has developed a lot of useful information for the natural area practitioner interested in designing status surveys and trends monitoring of species and natural communities (URL: http://science.nature.nps.gov/im). Long-term monitoring projects at the national level include the North

American Breeding Bird Survey (U.S. Geological Survey and Canadian Wildlife Service) and the U.S. Forest Service's Forest Inventory and Analysis Program. In Missouri, the Missouri Ozark Forest Ecosystem Project (MOFEP) is a long-term monitoring project examining forest management practices on forest and woodland natural communities of the Ozarks (Shifley and Kabrick 2002). The Missouri Department of Natural Resources monitors water quality at selected streams throughout the state for biological, physical, and chemical parameters and has established biological and chemical water quality standards. In short, there are a number of biological monitoring projects at a variety of scales being carried out by many organizations that can and do inform natural area management practices.

For natural area monitoring, the important thing is to first identify the focal conservation targets – species and or natural communities – which will serve as the foci for monitoring efforts (Parrish et al. 2003). Then the key ecological attributes of the monitoring target(s) need to be identified as well as what an acceptable range of variation is for those attributes. For example, Mead's milkweed, a species listed as threatened by the U.S. Fish and Wildlife under the Endangered Species Act, might be a key conservation target at a natural area. The key attributes could include number of stems, number of flowers, and number of fruits produced by Mead's milkweed. The acceptable range of variation could be defined as a "trigger point" whereby if density declines below 100 stems then a change in burn regime will be investigated and seeds will be collected for off-site propagation. Then a monitoring approach could be developed with sampling techniques developed to assess the key attributes. Investigators would then determine the statistical error levels (Type I and II) they can tolerate and the smallest amount of change in the attributes they want to detect and the smallest number of years over which they want to detect changes (Elzinga et al. 2001). This will inform the sample size and the frequency of sampling. First year data collection might indicate a need to revise sample sizes based on variability in the metrics sampled. This is the basic framework for monitoring. Note that a continuum exists between no monitoring and fully replicated research experiments. Elzinga et al. (2001) point out a key consideration is that for most natural resources monitoring cause and effect cannot be statistically inferred. Only for intensive monitoring projects – research – can cause and effect be statistically inferred (James and McCulloch 1995). Most natural area monitoring projects will be unreplicated observational studies because of time and budget constraints of most natural area owners.

Guidelines

- Natural areas should be visited at least once a year by area managers or other trained staff or volunteers to qualitatively assess the site for threats to conservation targets (natural communities and rare/declining species). Basic natural area status reports include a walk or float through of the site to assess invasive species impacts, human disturbances (e.g., ATV traffic), degree of public use, natural disturbances (e.g., ice-storm damage), general ecological integrity, and management impacts (e.g., prescribed burn results). A sample Natural Area Status Report is found in the next section of this manual to guide these efforts. Status reports should be shared with appropriate staff within the organization responsible for the natural area and saved in a file system to preserve a site management history. Major changes in a natural area (e.g., a catastrophic wind-storm or extensive ATV trespass) should be shared with MoNAC as a courtesy.
- The Missouri Natural Heritage Program provides a database for determining broad status and trends of Missouri's species of conservation concern and natural communities. Natural area practitioners should use and provide data to this Database.
- Monitoring the vegetation of terrestrial natural communities and monitoring fish and or benthic macroinvertebrate assemblages of aquatic natural communities are regarded as good general indicators of a natural area's ecological integrity.
- Species listed as federally threatened or endangered by USFWS under the Endangered Species Act or as state endangered by the Missouri Wildlife Code should receive priority for species-

level monitoring efforts on natural areas. Other declining Missouri species of concern (especially those listed as S1-S3 and G1-G3, Missouri Natural Heritage Program 2010) are priority species-level monitoring targets.

- Before embarking on any monitoring project, devote substantial thought to the basic questions of the why, what, and how of monitoring.
- A defensible monitoring program should (Mulder et al. 1999, Fancy et al. 2009): (1) Clearly state management goals and objectives, (2) Provide a clear statement of why the monitoring program is important, (3) Develop a conceptual ecological model of how the system works based on existing information, (4) Select indicators or metrics that can be measured simply and cost-effectively, (5) Develop sampling and measurement protocols, (6) Determine the level of statistical precision required, and (7) Include procedures to link monitoring results to management decisions.
- Permanent plots that are revisited over time are recommended for monitoring, because the objective is to determine changes over time, and permanent plots aid in statistical rigor in analyzing biological change over time.
- The U.S. Geological Survey's Patuxent Wildlife Research Center has developed a set of choices that natural resource managers should consider in developing a long-term trends monitoring program: What is the goal of the monitoring? What species or communities will you monitor? What is the study area? What counting technique will you use to monitor? How will you analyze the data to determine trends? What Type I and II error levels will you use? What is the smallest number of years over which you want to detect change? What is the smallest amount of change you want to detect? How will you determine sample size? Where will you locate your plots? How frequently will you sample? What time of year will you sample? How many days will field collection and data analysis take? How much will this project cost in time and money?
- Monitoring projects should establish "trigger points" or "thresholds" at which management regimes or conservation practices will be re-evaluated if monitoring targets fall below some pre-defined metric value over some pre-determined period of time.
- For monitoring the ecological integrity of the plant community aspect of natural communities utilizing the floristic quality index (FQI) approach is recommended (see Taft et al. 1997, Masters 1997, and Taft et al. 2006). Examples of Missouri monitoring projects using the floristic quality index approach include those of the prairie communities at Regal Tallgrass Prairie NA at Prairie State Park (Currier et al. 2004), the woodland communities at Caney Mountain Natural Area (Rimer 2005), and the Mark Twain National Forest Pineknot Pine Restoration Project (Heumann and Ladd 2006). The Missouri Field Office of The Nature Conservancy as well as the MoDNR – Division of State Parks have extensively used an FQI approach to their vegetation monitoring. Ladd (1996, 1997) has created a list of "coefficients of conservatism" for Missouri's vascular plant species to use in FQI monitoring studies. This list is currently being revised and updated to parallel taxonomic and nomenclatural changes to Missouri's vascular flora.
- A variety of different plot sizes and sampling designs have been used to monitor vegetation on natural areas – consult individual studies, MoNAC members, and other ecologists for guidance.
- Monitoring of terrestrial bird (Ralph et al. 1995), herptile (Heyer et al. 1994), small mammal (Wilson et al. 1996) and insect species populations all have specialized techniques of which there are many (Yoccoz et al. 2001, Marsh and Trenham 2008). Consult experts in these fields for guidance.
- For monitoring the ecological integrity of stream natural communities, use of information on fish species and benthic macroinvertebrate taxa populations is a recommended approach (Karr and Chu 1999). Indices of biological integrity have been developed for Missouri streams regarding Ozark fisheries (Doisy et al. 2008) and benthic macroinvertebrates (Sarver et al. 2002). Nitrates, phosphates, turbidity, conductivity, dissolved oxygen, temperature, and pH are key chemical and

physical attributes to consider in stream monitoring programs. However, using organisms alone as indicators of physical and chemical conditions of the stream has advantages (Barbour et al. 1999, USEPA 2006). Even long-term monitoring of a stream reach designated as a natural area using the methodology of the Missouri Stream Team (URL: http://www.mostreamteam.org) can provide important data on ecological conditions and can serve as a warning signal of stream impairment problems (Engel and Voshell 2002). Managers are encouraged to direct Stream Team water quality monitoring volunteers to aquatic natural areas or become Stream Team water quality monitoring volunteers themselves.

- Monitoring techniques of cave waters and fauna can be highly technical. Elliott (2007) maintains a Cave Life Database that is used to track Missouri's rich cave fauna. The Ozark Underground Laboratory has developed and provided long-term monitoring techniques and data for cave communities using Tumbling Creek Cave as a model ecosystem (Elliott and Aley 2006). Long-term monitoring studies of Missouri's Indiana and gray bats have occurred (Clawson et al. 2006). The Cave Research Foundation has conducted cave exploration and monitoring of Powder Mill Cave NA for many years. Consult a cave biologist for assistance with cave community monitoring.

Standard Natural Area Forms (Nomination, Addition, Delisting, Status Report, Cooperative Registry Agreement, Director's Approvals) and Instructions

Standardized forms assist with maintaining continuity and efficiency in MoNAC operations and maintaining the master natural areas files housed in the central office of the Missouri Department of Conservation. For the forms below, a blank form (template) precedes a form with instructional information. Standard fields are in **bold** text and descriptions of non self-explanatory fields are in regular text for the instructional forms. Some forms below need no instructions. Note that for Natural Area Status Reports, an example is provided that can be modified as needed by MoNAC organizations for internal natural area status reporting purposes. Forms start on the following page.

MISSOURI NATURAL AREA NOMINATION FORM template

Name of Area: **Nomination Date:**
Prepared By: **Inspection Date(s):**

Principal Feature(s) (Name and EO Code or EO ID):

Rare or Endangered Species (Name, Status and EO Code or EO ID):

Conservation Value:

Owner or Public Land Unit:

Ecological Section/Subsection:

Ecological Drainage Unit (if nomination includes aquatic principal features):

County: **Quadrangle:**

Twsp: **Range:** **Sections/Fractions:**

Size:

Boundaries:

DESCRIPTION OF AREA

Topography:

Geology:

Soils:

Geologic Features:

Hydrology (for nominations with wetland or aquatic principal features):

Natural Communities:

Other Features:

Historic Vegetation (GLO Notes, Historic Accounts, Local Information):

Land Use History:

Grazing:
Logging:
Fire:
Litter:
Travelways:

Adjacent Land Uses:

Threats (threats analysis):

Recommended Additions:

Supporting Information:

Literature Cited:
Additional References:

Species Lists:
Maps:
Photographs:

Missouri Natural Areas Committee Natural Area Management Recommendations*

Area Name:

Administrative Agent:

Management Goals (including management of buffer land):

Ecological Management Objectives:

Development Objectives:

Recreational Uses:

Research Uses and Needs:

Date Submitted:
Committee Approval Date:
Prepared By:

*The management recommendations become a management plan or set of management objectives once the area is formally designated.

MISSOURI NATURAL AREA NOMINATION FORM instructions

Name of Area: **Nomination Date:** Date approved by both MDC and MoDNR directors.
Prepared By: **Inspection Date(s):** Dates of field inspections.

Principal Feature(s) (Name and EO Code or EO ID): The natural communities and geologic features for which the natural area is being nominated. Names follow types as described in Nelson (2010) for terrestrial natural communities (including caves), Pflieger (1989) for aquatic natural communities, and Hebrank (1989) for geologic features. Principal features typically receive the rank of "significant" or "exceptional" according to the methods of the Missouri Natural Features Inventory (Appendix B). They are of statewide or regional ecological importance. EO Code refers to "element occurrence" code and EO ID refers to "element occurrence" identification number. These are unique identifier codes used by the Missouri Natural Heritage Database for the location of a natural community or species of conservation concern site. Provide the grade (A-C) of the community feature too, also known as "element occurrence rank" in the Database. Include approximate acreages, stream miles, or length of main cave passageway for terrestrial, aquatic, or cave communities listed, respectively.

Rare or Endangered Species (Name, Status and EO Code or EO ID): The name(s) of Missouri species of conservation concern that are tracked by the Missouri Natural Heritage Database and located on the natural area. Status indicates the state and global ranks used by the Database (Missouri Natural Heritage Program 2010). EO Code refers to "element occurrence" code and EO ID refers to "element occurrence" identification number. These are unique identifier codes used by the Missouri Natural Heritage Database for the location of a natural community or species of conservation concern site. Provide the grade (A-D) of the population too, also known as "element occurrence rank" in the Database.

Conservation Value: A narrative description of why this site merits natural area status. Often includes an analysis of other natural areas within the same ecological subsection or drainage unit to show that the potential natural area site under consideration fills a gap in the natural areas system in terms of protecting natural communities and geologic features.

Owner or Public Land Unit:

Ecological Section/Subsection: Terrestrial ecological geography of the site down to the subsection level using the system developed by Nigh and Schroeder (2002).

Ecological Drainage Unit (if nomination includes aquatic principal features): Aquatic ecological geography of the site down to the ecological drainage unit level using the system developed by Sowa et al. (2007).

County: **Quadrangle:** U.S. Geological Survey 7.5" topographic quadrangle(s)

Twsp: Range: Sections/Fractions: Standard Public Land Survey description of the site's location to at least the section level.

Size: in acres.

Boundaries: Brief narrative of the features of the boundaries of the natural area, e.g. roads, ridgetops, ownership boundaries, etc…

DESCRIPTION OF AREA

Topography: Brief narrative of the landforms, relief, steepness, and drainage patterns of the site.

Geology: Brief description of the bedrock and surficial materials geology of the site and any rock outcrops.

Soils: Brief description of the dominant soil series of the site and the relationship between natural communities and these.

Geologic Features: Any notable geologic features not mentioned in the principle features above.

Hydrology (for nominations with wetland or aquatic principal features): A brief discussion of the hydroperiod, drainage patterns, water budget, and flooding or inundation patterns for wetland communities. A brief discussion of a stream's order (size), discharge, watershed attributes, and hydrograph for stream natural communities.

Natural Communities: A detailed description of the principal feature natural communities in terms of their name, size, natural quality (grade), dominant (up to 10) and characteristic species (up to 20) – plants for terrestrial sites, fishes or benthic macroinvertebrates for aquatic sites, and cave adapted fauna, especially troglobites, for caves – and associated rare/endangered species. Follow descriptions of natural communities based upon Nelson (2010) for terrestrial (including caves) and Pflieger (1989) for aquatic natural communities. Delineate between significant, exceptional, and notable communities (Appendix B). If additional data are available, such as herptile surveys, for natural communities, include a brief description of that data here. Species lists should be placed at the end of the nomination. Species lists need not be exhaustive but should provide enough information on conservative or remnant-dependent plant and animal species to allow for a judgement of the conservation value of the site. Describe problems with invasive species and negative human disturbances here as well.

Other Features: Other natural features of note, such as importance of a site for migratory birds.

Historic Vegetation (GLO Notes, Historic Accounts, Local Information): Information on the presettlement vegetation of the site based upon General Land Office (GLO) surveys (see Schroeder 1981 for a description of the GLO methods and history) or local historical accounts. GIS layers of Missouri's GLO records are now available for the entire state and provide a powerful and now easily accessible tool to analyze the historic vegetation patterns of the region surrounding a natural area site (Missouri historic vegetation and hydrography layers are available from the Missouri Spatial Data Information Service, URL: http://msdis.missouri.edu/). Another source of historic vegetation data are historical aerial photos (from the 1930s – 1960s). County NRCS offices sometimes have these and they are also available at the State Historical Society of Missouri located at the University of Missouri-Columbia. The National Archives also stores a number of Missouri historic aerial photos that can be reproduced and bought from them.

Land Use History: Briefly describe what is known about the past land uses, including grazing, cropping, logging, wildfire, trash dumping, and roads.

Grazing:
Logging:
Fire:

Litter:
Travelways: Roads and trails crossing the site.

Adjacent Land Uses: List the current land uses adjacent to the site, such as fescue pasture.

Threats (threats analysis): What are the principal threats to the viability of the natural area, current and potential (TNC 2000)? For example, garlic mustard may currently threaten the site but development of surrounding lands to housing may threaten the site in the next 5-10 years.

Recommended Additions: What adjacent parcels of lands and waters would be beneficial to add to the natural area in the future if they were to become available for purchase and or restored to natural area quality?

Supporting Information:

Literature Cited: Directly cited materials.

Additional References: Non-cited materials used.

Species Lists: Species lists need not be exhaustive but should provide enough information on conservative or remnant-dependent plant and animal species to allow for a judgment of the conservation value of the site.

Maps: Attach the following three maps at a minimum: (1) a vicinity map (1:50,000 to 1:100,000 scale) with surrounding conservation sites and public lands if appropriate, and a state locator inset; (2) natural area boundaries on a 1:24,000 scale topographic map or aerial image map; and (3) natural community boundaries on a 1:24,000 scale topographic map with principal features identified and all high-quality natural community sites identified and classified. Other pertinent maps detailing natural community grades, soils, past management practices, flooding patterns, and presettlement vegetation may be included**.**

Photographs: A few representative photos of the site are nice to include but not required. Representative slides or photos of the area must be presented to MoNAC at a nomination hearing.

Missouri Natural Areas Committee Natural Area Management Recommendations**

Area Name:

Administrative Agent: The land managing entity.

Management Goals (including management of buffer land): The overall goals for the management of the natural area. Typically these are to protect, restore, and maintain the site's natural communities and their constituent species.

Ecological Management Objectives: Management objectives needed to further the goals. Examples include objectives for prescribed burns, invasive species control, selective thinning, and hydrologic restoration. Monitoring objectives to track the effectiveness success of these measures towards meeting the conservation goals are included here as well.

Development Objectives: These objectives relate to the need for infrastructure development or

maintenance at the natural area. Examples include public access points (parking), trails, interpretive signs, management access roads, and boundary signs.

Recreational Uses: Permitted public uses of the natural area such as hiking, bird watching, fishing, or hunting. Describe any existing trails or the need to develop trails here as they relate to public use.

Research Uses and Needs: Briefly outline the need for both research and monitoring projects for the natural area. These can include status surveys as well as trends monitoring to more complex experimental designs (research).

Date Submitted: Date the nomination was forwarded to MoNAC.
Committee Approval Date: Date MoNAC approved the nomination.
Prepared By:

** The management recommendations become a management plan or set of management objectives once the area is formally designated

MISSOURI NATURAL AREA ADDITION FORM template

Name of Area: **Nomination Date:**
Prepared By: **Inspection Date(s):**

Principal Feature(s) (Name and EO Code or EO ID):

Rare or Endangered Species (Name, Status and EO Code or EO ID):

Owner or Public Land Unit:

County: **Quadrangle (If different than previously nominated area):**

Twsp: **Range:** **Sections/Fractions:**

Size of this Addition:

Total Natural Area Size:

Boundaries:

DESCRIPTION OF ADDITION:

General Description:

Natural Communities:

Land Use History:

Threats (threats analysis):

Management Recommendations*:**

Supporting Information:

Literature Cited:
Additional References:

Species Lists:
Maps:
Photographs:

*** The management recommendations become a management plan or set of management objectives once the area is formally designated

MISSOURI NATURAL AREA ADDITION FORM instructions

Name of Area: **Nomination Date:** Date approved by both MDC and MoDNR directors.

Prepared By: **Inspection Date(s):** Dates of field inspections.

Principal Feature(s) (Name and EO Code or EO ID): The natural communities and geologic features for which the natural area addition is being nominated. Names follow types as described in Nelson (2010) for terrestrial natural communities (including caves), Pflieger (1989) for aquatic natural communities, and Hebrank (1989) for geologic features. Principal features typically receive the rank of "significant" or "exceptional" according to the methods of the Missouri Natural Features Inventory (Appendix B). They are of statewide or regional ecological importance. EO Code refers to "element occurrence" code and EO ID refers to "element occurrence" identification number. These are unique identifier codes used by the Missouri Natural Heritage Database for the location of a natural community or species of conservation concern site. Provide the grade (A-C) of the community feature too, also known as "element occurrence rank" in the Database. Include approximate acreages, stream miles, or length of main cave passageway for terrestrial, aquatic, or cave communities listed, respectively.

Rare or Endangered Species (Name, Status and EO Code or EO ID): The name(s) of Missouri species of conservation concern that are tracked by the Missouri Natural Heritage Database and located on the natural area addition. Status indicates the state and global ranks used by the Database (Missouri Natural Heritage Program 2010). EO Code refers to "element occurrence" code and EO ID refers to "element occurrence" identification number. These are unique identifier codes used by the Missouri Natural Heritage Database for the location of a natural community or species of conservation concern site. Provide the grade (A-D) of the population too, also known as "element occurrence rank" in the Database.

Owner or Public Land Unit:

County:

Quadrangle (If different than previously nominated area): U.S. Geological Survey 7.5" topographic quadrangle(s)

Twsp: Range: Sections/Fractions: Standard Public Land Survey description of the site's location to at least the section level.

Size of this Addition:

Total Natural Area Size:

Boundaries: Brief narrative of the features of the boundaries of the natural area addition, e.g. roads, ridgetops, ownership boundaries, etc…

DESCRIPTION OF ADDITION:

General Description: A brief description of the topography, geology, soils, and hydrology of the site if substantially different than the original natural area.

Natural Communities: A description of the principal feature natural communities of the addition in

terms of their name, size, natural quality (grade), dominant (up to 10) and characteristic species (up to 20) – plants for terrestrial sites, fishes or benthic macroinvertebrates for aquatic sites, and cave adapted fauna, especially troglobites, for caves – and associated rare/endangered species. Follow descriptions of natural communities based upon Nelson (2010) for terrestrial (including caves) and Pflieger (1989) for aquatic natural communities. Delineate between significant, exceptional, and notable communities (Appendix B). If additional data are available, such as herptile surveys, for natural communities, include a brief description of that data here. Species lists should be placed at the end of the nomination. Species lists need not be exhaustive but should provide enough information on conservative or remnant-dependent plant and animal species to allow for a judgement of the conservation value of the site. Describe problems with invasive species and negative human disturbances here as well.

Land Use History: A brief narrative of the site's land use history if different than the original nomination.

Threats (threats analysis): A brief narrative of the principal threats to the addition if different than the original nomination.

Management Recommendations: A brief description of the ecological management and development objectives of the site as well as information on allowable recreational uses and research uses and needs if different than the original nomination. May include a substantial revision to the original nomination's management recommendations if needed, especially for additions to older nominations (nominations prior to 1990). The management recommendations become a management plan or set of management objectives once the area is formally designated

Supporting Information:

Literature Cited: Directly cited materials.

Additional References: Non-cited materials used.

Species Lists: Species lists need not be exhaustive but should provide enough information on conservative or remnant-dependent plant and animal species to allow for a judgment of the conservation value of the site.

Maps: Attach the following three maps at a minimum: (1) a vicinity map (1:50,000 to 1:100,000 scale) with surrounding conservation sites and public lands if appropriate, and a state locator inset; (2) natural area boundaries of the original and proposed addition on a 1:24,000 scale topographic map or aerial image map; and (3) natural community boundaries of the proposed addition on a 1:24,000 scale topographic map with principal features identified and all high-quality natural community sites identified and classified.

Photographs: A few representative photos of the site are nice to include but not required. Representative slides or photos of the area must be presented to MoNAC at a nomination hearing.

NATURAL AREA DELISTING REPORT template

Name of Natural Area: **Date:**
Designation Date: **Size:**

Ecological Classification System:
County:
Natural Area Owner:
Natural Area Manager:
Managed Area Name:
Maps:

Natural community type(s) or other natural feature(s) the area was designated to represent:

Is the site defendable as a Missouri Natural Area?:

Has the value of the area for which it was recognized been destroyed by outside influences?:

Was the scientific knowledge base at the time of nomination inadequate or inaccurate to support nomination today?:

When was the area last inspected? What was found regarding the natural community conditions?:

Does the area have the size, surrounding land condition and use, and boundaries that can contribute to long term viability of the features? Does the site allow for enough management flexibility to provide for restoration of crucial ecological processes?:

Can the natural area boundaries be moved or expanded to include higher quality natural communities or to create a more ecologically sound, well-buffered area that would then qualify as a natural area?:

Are there other known areas with the same community type in the same ecological subsection or drainage unit that can be designated or are already designated?:

What are the area manager's recommendations on delisting?:

What will be the post-natural area designation management of the area?:

Will there be public concern/political sensitivity over delisting? How will that issue be handled?:

Are there other protection tools that apply to the area such as deed restrictions or conservation easements?:

NATURAL AREA DELISTING REPORT instructions

Name of Natural Area: **Date:** Date this report first submitted to MoNAC.
Designation Date: Date natural area was originally approved by the directors of MDC and DNR. **Size:**

Ecological Classification System: The ecological subsection (Nigh and Schroeder 2002) or ecological drainage unit (Sowa et al. 2007) the area lies in.

County:
Natural Area Owner: Who is the land owner?
Natural Area Manager: Who is the land managing entity?
Managed Area Name: Is the natural area located in a larger land ownership, such as a state park, and what is the name of that entity?

Maps: Please attach two maps: (1) a vicinity map (1:50,000 to 1:100,000 scale) with surrounding conservation sites and public lands if appropriate, and a state locator inset and (2) natural area boundaries on a 1:24,000 scale topographic map or aerial image map.

Natural community type(s) or other natural feature(s) the area was designated to represent:
At the time of nomination what principal features were listed as the justification for natural area status? Cross-walk old natural community types or geologic features to currently accepted types if possible. Describe the acreage and natural quality of these features at the time of their nomination and currently.

Is the site defendable as a Missouri Natural Area?:
Would it be considered as a natural area candidate today – is it a state-wide significant or regionally significant (exceptional) feature? Is this the best known example of this community type in the state? Is this the best known example of this community type at the ecological subsection or drainage unit scale? What are the current grades (A-E) and ranks (Significant, Exceptional, Notable, Unranked) of the natural communities within the area, using the criteria of the Missouri Natural Features Inventory? Have better areas representing the same features been designated since this area was designated, or are there better examples that could be designated?

NOTE: The rest of the fields of the delisting report consist of self-explanatory questions to answer. See the template.

An Example NATURAL AREA STATUS REPORT template

Area Name:
Fiscal Year:
Calendar Year:
Owner:
Land Managing Entity:
County:
Acres:

Area Manager Name and Address:

Dates of Inspection by staff (please inspect facilities and major use areas at least quarterly; walk through entire area at least once per year):

Submitted by:

Management Goal(s):

Objective 1:
Objective 2:
Objective 3:

Management Progress: List management activities completed or ongoing for the past fiscal year that help to achieve the above management objectives:

1.
2.
3.

LAND MANAGEMENT ACTIVITIES:

Check activities conducted during the last fiscal year:			
☐ Prescription burn	☐ Brush cutting/control	☐ Exotic/invasive species control	☐ Trail maintenance
☐ Litter cleanup	☐ Fence repair or construction	☐ Sign placement or replacement*	☐ Native species plantings
☐ Hydrologic restoration	☐ Other (specify):		
☐ Deer hunting program	☐ Tree thinning	☐ Fireline preparation	☐ Facility maintenance**
Details (Give a brief description of locations, acreages or other measurements, dates, results, and other specifics of the above as needed):			

*Signs include boundary, interpretive, identification (features/trails/cantilever), and regulation types.
**Facilities include fences, gates, parking lots, access roads, trails, boardwalks, brochure holders, kiosks, and overlooks.

Use of the Area: Has public use of the area changed significantly from previous years? Circle one, YES or NO. If yes, how has it changed?

APPROPRIATE VISITOR USE (Please provide the following information):

Attendance (Quarterly Visits)	Basis for Attendance Figures (circle one or more)	Activities Observed (Check one or more)	
Spring: Summer: Fall: Winter:	Estimate Actual Count Periodic Count	☐ Hiking ☐ Nature Studies ☐ Guided Walks ☐ Other: ☐ Fishing	☐ Wildlife Watching ☐ Youth Group Education ☐ Research ☐ Hunting

List any scientific studies, collections, biological inventories, or special public use events on this area in this Fiscal Year:

Please indicate if volunteers are helping in the natural area in terms of the organization, number of persons involved, number of days worked per year, and the work performed:

<u>Management Problems:</u> List the most significant problems that may degrade the natural quality or integrity of the area (e.g., new invasive species, illegal ATV-use, etc…)

1.
2.
3.

UNAUTHORIZED OR ILLEGAL ACTIVITIES REPORTED:

Check if these activities have occurred or been observed:

☐ Camping	☐ Poaching	☐ ATV use	☐ Horse use
☐ Collecting	☐ Motorized vehicles	☐ Camp fires	☐ Littering
☐ Dumping	☐ Bicycles	☐ Undesignated trails	☐ Rock Climbing/rapelling
☐ Vandalism to trails	☐ Vandalism to fences	☐ Vandalism to natural features	☐ Vandalism to signs
☐ Other (specify)			

Details (Give a brief description of dates, locations, damages, and other specifics of the above as needed):

Was law enforcement contacted? Circle one, YES or NO.

CHANGES OCCURRING IN THE NATURAL AREA:

Check those conditions that apply. Include map if appropriate.

☐ Invasive/exotic herbaceous plants	☐ Invasive/exotic woody plants	☐ Native animal populations	☐ Exotic animal population
☐ Native plant populations	☐ Large scale tree mortality	☐ Wildfire	☐ Wind damage
☐ Ice damage	☐ Flooding	☐ Erosion	☐ Siltation
☐ Water level changes	☐ Insect/Disease outbreaks	☐ Stream bank erosion	☐ Other (specify):

Details (Give a brief description of locations, acreages or other measurements, dates, impacts, and other specifics of the above as needed):

<u>Activities Planned for the Next Fiscal Year:</u> Briefly describe planned management actions to address the management objectives and problems identified above.

<u>Reporting Map</u>
Using either a GIS map or scanned area map, please delineate sites of land management activities, management problems, and major changes to the area in the Fiscal Year and attach the map to this report.

COOPERATIVE AGREEMENT
TO
REGISTER NATURAL AREAS

THIS AGREEMENT is made and entered into this ___ day of_____, 20XX, by and between _____ hereinafter referred to as "LANDOWNER," and the Missouri Department of [Conservation or Natural Resources], hereinafter referred to as "DEPARTMENT."

WHEREAS, LANDOWNER is the owner of the following described property located in X County, Missouri, and more particularly described as follows, to wit:

WHEREAS, said land described above has a high value as a natural area under criteria established by the DEPARTMENT, and it is the desire of the DEPARTMENT that said property be designated as a natural area and that this land be identified, used and managed as a natural area and be left in a natural or nearly undisturbed state, and

WHEREAS, it is the desire of the LANDOWNER that the land described above be formally registered and designated as a natural area by the DEPARTMENT in accordance with this Cooperative Agreement,

NOW, THEREFORE, in consideration of the mutual promises stated herein, the parties agree as follows:

(1) The land described above, when formally registered and designated as a natural area by the DEPARTMENT, shall be managed and used by LANDOWNER, his lessees or assigns, only in such ways as to fully protect and preserve its natural biological features.

(2) LANDOWNER shall permit inspection and allow access to the property at least semiannually by representatives of the DEPARTMENT, and may permit visitation by the general public as LANDOWNER deems appropriate, provided such visitation does not diminish the natural values of the area as defined by the DEPARTMENT.

(3) LANDOWNER shall erect signs which will be provided by the DEPARTMENT, as may be mutually agreed to, to designate the boundaries of the natural area.

(4) The property may be listed and described in the DEPARTMENT's natural area records and publications stating the name of the LANDOWNER and the restrictions, if any, on public visitation and any additional information the DEPARTMENT may deem appropriate pertaining to the natural area.

(5) The DEPARTMENT agrees to provide at its expense, natural area signs for the boundary of the designated area described herein; to list the area in its natural area publications; to help protect the area from degradation or loss of its natural values; and to develop a management plan and provide advice and guidance to the LANDOWNER to the end that the area may maintain its full range of natural

values.

(6) This agreement may be terminated by either party on thirty (30) days written notice, and following such termination the DEPARTMENT shall, within one hundred twenty (120) days, remove all signs from the area and shall, at the next reprinting following termination, delete reference to the area in its natural areas publications.

(7) It is agreed that if, during the term of this agreement, LANDOWNER, his heirs, or assigns, should desire to sell said premises, then the DEPARTMENT shall have the right of the first refusal and privilege of purchasing the same for the same price for which the LANDOWNER would be willing to sell to any other person; but, if the DEPARTMENT shall not exercise said option of purchase within thirty (30) days after notice in writing from LANDOWNER, his heirs, or assigns, of such desire to sell, then LANDOWNER may thereafter sell said premises to any other person.

(8) If this land is transferred by the LANDOWNER to another owner, then this agreement will be automatically terminated, but the DEPARTMENT will have one hundred twenty (120) days to remove all signs from the area.

IN WITNESS WHEREOF, the LANDOWNER and the DEPARTMENT have caused this agreement to be executed the date first above written.

LANDOWNER:

_____

DEPARTMENT:
Missouri Department of [Conservation or Natural Resources]

_____
Director, XX

Agency Legal Counsel Review: _____

MISSOURI DEPARTMENT OF CONSERVATION
MISSOURI DEPARTMENT OF NATURAL RESOURCES
MARK TWAIN NATIONAL FOREST
OZARK NATIONAL SCENIC RIVERWAYS
U.S. FISH & WILDLIFE SERVICE
THE NATURE CONSERVANCY

MISSOURI NATURAL AREAS APPROVAL FORM

The Missouri Natural Areas Committee recommends the _____ Natural Area for designation [addition, delisting] as a designated Missouri Natural Area.

_____ _____
Chairperson, Date
Missouri Natural Areas Committee

_____ _____
Director, Date
Missouri Department of Natural Resources

_____ _____
Director, Date
Missouri Department of Conservation

Approval by the Department of Conservation and the Department of Natural Resources constitutes joint designation of an area as a Missouri Natural Area.

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MEMORANDUM OF UNDERSTANDING
between the
MISSOURI DEPARTMENT OF CONSERVATION
MISSOURI DEPARTMENT OF NATURAL RESOURCES
USDA FOREST SERVICE, MARK TWAIN NATIONAL FOREST
OZARK NATIONAL SCENIC RIVERWAYS
U.S. FISH AND WILDLIFE SERVICE
THE NATURE CONSERVANCY
for
Coordination of a State Natural Areas Program

WHEREAS, the Missouri Natural Areas Committee was formed April 20, 1977, by joint agreement between the Missouri Department of Conservation and Missouri Department of Natural Resources to coordinate the classification, inventory, designation and stewardship of Missouri's most significant natural features; and

WHEREAS, the Missouri Natural Areas Committee has fostered a strong public awareness of Missouri's terrestrial and aquatic natural communities and geological features, that are maintained for the enjoyment of all, the education of students and beneficial scientific studies; and

WHEREAS, it is the policy of the Missouri Department of Conservation (MDC) and the Missouri Department of Natural Resources (MDNR) that "natural areas" shall be identified and preserved. Natural areas are defined as biological communities or geological sites that preserve and are managed to perpetuate the natural character, diversity and ecological processes of Missouri's native landscapes. They are to be permanently protected or managed for the purpose of preserving their natural qualities; and

WHEREAS, all parties specify that an official designation as a Missouri Natural Area represents the highest and best use of these tracts and no party will authorize any use or diversion of such areas that is incompatible with the objectives of natural area protection unless there is critical public need for which there is no alternative; and

WHEREAS, the collaboration of state and federal agencies and The Nature Conservancy, as an advisory member of the Missouri Natural Areas Committee, is an example of successful conservation partnerships, and all parties recognize that a truly statewide Missouri Natural Areas Program will be best implemented by the mutual and cooperative efforts of all agencies, organizations, and individuals who have an interest in natural areas; and

WHEREAS, the Director of the Missouri Department of Natural Resources and the Director of the Missouri Department of Conservation will each appoint four representatives from their respective agencies to serve as a Missouri Natural Areas Committee. The National Park Service, the U.S. Forest Service, and the U.S. Fish and Wildlife Service may also appoint one voting member each to the Committee. The Missouri Chapter of The Nature Conservancy may also serve as an advisor to the Committee with one voting member.

NOW, THEREFORE, the Missouri Natural Areas Committee (MONAC) shall:

1. Designate from its MDNR or MDC members one person each to serve as chair and vice chair of MONAC. The chair and vice chair shall not be from the same agency. The chairing agency shall coordinate activities of MONAC, be a spokesperson, and be responsible for staff support including preparation and distribution of agendas, minutes, and other administration functions as appropriate. Chair responsibilities, including Natural Area Newsletter administration and production, shall rotate between MDNR and MDC on a three-consecutive-year cycle, commencing with the calendar year that the chair is designated.

2. Invite interested agencies, organizations and individuals to participate in MONAC meetings and other functions, as deemed appropriate.

3. Consider areas nominated for natural area designation. Nominations may originate with MDC, MDNR, other agencies, organizations, or private individuals. It shall be the responsibility of MONAC to coordinate the nomination of natural areas so as to encompass within the Missouri Natural Areas System the greatest possible diversity of natural communities, which represent the highest quality Missouri ecosystems in amounts, sizes and geographic distribution, and with sufficient redundancy, for long-term protection of Missouri's biological and geological diversity.

4. Areas selected by MONAC as suitable for natural area designation shall be recommended for such designation to the agency, organization, or individual having administrative responsibility for the recommended areas, with copies of the MONAC recommendation to the heads of MDC and MDNR . Approval of the recommendation by the responsible administering entity, MDC and MDNR, shall constitute joint designation of the area as a unit of the Missouri Natural Areas System.

5. Natural area designation may be removed from an area if better, more representative natural communities of the same type are located and designated, or if the value of the area is destroyed by outside influences. However, some redundancy and duplication of types is desirable to achieve good geographic distribution and to assure adequate protection. MONAC will consider recommendations from the administering entity for removal from the Natural Areas System in accordance with procedures for careful review of such requests. Submittal procedures will be similar to those for designation, except that recommendations to remove natural area designation from an area must be considered at two separate MONAC meetings to assure time for thorough review of the action.

6. Maintain an official registry of designated Missouri Natural Areas in the offices of MDC, and in other places as deemed desirable, maintain additional records and documents, and provide for public information concerning the program. MONAC shall develop or adopt forms and standards to achieve conformity in records, reports, and signage.

7. Recommend general management guidelines for natural areas, and review, endorse, or comment on management plans for natural areas.

8. Provide for systematic inspections of designated natural areas.

9. Develop and distribute publications and other public information about designated natural areas and the Missouri Natural Areas System.

It is mutually understood and agreed by and between the parties that:

FREEDOM OF INFORMATION ACT (FOIA). Any information furnished to the Forest Service under this instrument is subject to the Freedom of Information Act (5 U.S.C. 552).

PARTICIPATION IN SIMILAR ACTIVITIES. This instrument in no way restricts the Forest Service or the Cooperator(s) from participating in similar activities with other public or private agencies, organizations, and individuals.

COMMENCEMENT/EXPIRATION/TERMINATION.
This agreement will become effective upon signature of the Missouri Department of Conservation, Missouri Department of Natural Resources, Forest Service, Ozark National Scenic Riverways, U.S. Fish and Wildlife Service, and The Nature Conservancy and shall remain in effect for a period of five (5) years beginning on the date of execution. Extensions, amendments, or other modifications to this agreement shall be agreed to in writing and signed by all parties hereto. Either of the parties hereto may terminate their involvement in this agreement upon a sixty-day (60-day) written notice to the others.

RESPONSIBILITIES OF PARTIES. All parties hereto and their respective agencies and offices will handle their own activities and use their own resources, including the expenditure of their own funds, in pursuing these objectives. Each party will carry out its separate activities in a coordinated and mutually beneficial manner.

PRINCIPAL CONTACTS. The principal contacts for this instrument are:

John Hoskins, Director
Missouri Department of Conservation
P.O. Box 180
Jefferson City, MO 65102-0180
Phone: 573-751-4115

Doyle Childers, Director
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102-0176
Phone: 573-751-3443

NON-FUND OBLIGATING DOCUMENT. This instrument is neither a fiscal nor a funds obligation document. Any endeavor or transfer of anything of value involving reimbursement or contribution of funds between the parties to this instrument will be handled in accordance with applicable laws, regulations, and procedures including those for government procurement and printing. Such endeavors shall be outlined in separate agreements that shall be made in writing by representatives of the parties and shall be independently authorized by appropriate statutory authority. This instrument does not provide such authority. This instrument does not establish authority for noncompetitive award to the cooperator of any contract or other agreement.

ESTABLISHMENT OF RESPONSIBILITY. This agreement is not intended to, and does not create, any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity, by a party against the United States, its agencies, its officers, or any person.

The parties hereto have caused this Agreement to be executed this 8th day of January, 2009.

MISSOURI DEPARTMENT OF CONSERVATION

By: John Hoskins
DIRECTOR

Date: 10-3-08

approved as to form:

General Counsel

Date: 10-2-08

MISSOURI DEPARTMENT OF NATURAL RESOURCES

By: Doyle Childers
DIRECTOR

Date: 11-26-08

approved as to form:

Sara L. Valentine
General Counsel

Date: 11-24-08

USDA FOREST SERVICE
MARK TWAIN NATIONAL FOREST

By:
FOREST SUPERVISOR

Date: 10/16/08

approved as to form:

Nicki Rogers
F.S. Agreements Coordinator

Date: 10/16/08

OZARK NATIONAL SCENIC RIVERWAYS

By: Reed Wentz
SUPERINTENDENT

Date: 1/8/09

approved as to form:

General Counsel

Date:

U.S. FISH AND WILDLIFE SERVICE

By: Charles M. Scott
for REGIONAL DIRECTOR

Date: 12/9/08

approved as to form:

General Counsel

Date:

THE NATURE CONSERVANCY

By: Doug Wolf
For MISSOURI DIRECTOR

Date: 30. Dec. 08

approved as to form:

General Counsel

Date:

Appendix B: Missouri Natural Features Inventory and Natural Heritage Database Terrestrial Natural Community Evaluation Procedures

Introduction

One of the goals of the Missouri Natural Features Inventory (NFI, 1981-2001) was to locate high-quality terrestrial natural community sites. This goal fit right into the goals of the Missouri Natural Areas Program. Today there still is a need to locate and evaluate terrestrial natural community sites on existing natural areas and new sites with potential for natural area status. The first step in an inventory is to develop a classification system. Nelson's (2010) *Terrestrial Natural Communities of Missouri* provides that framework. Previous editions of this book provided natural features inventory biologists their framework for natural community inventory.

The Missouri Natural Heritage Database

Missouri's Natural Heritage Database is part of a natural heritage program network run by NatureServe (URL: http://www.natureserve.org/). NatureServe is a network of member programs that collect and analyze data about the plants, animals, and ecological communities of the Western Hemisphere. The natural heritage methodology was originally developed by The Nature Conservancy in the 1970s. The role of the Missouri Natural Heritage Program is to collect, analyze, and distribute detailed scientific information about the biological diversity within the state. The focus is on the locations and conditions of rare, threatened, or endangered species (species of conservation concern) and natural communities. These data are critical for use by the Missouri Natural Areas Program in furthering its goals.

The strength of the Missouri Natural Heritage Database (NHD) is a standard methodology for identifying, inventorying, and mapping species and communities of conservation concern. Species and communities are collective referred to as "elements of biodiversity." Each specific location of a species population or community is referred to as an "element occurrence." The NHD methodology works best for plants and communities – less mobile elements of biodiversity. Natural heritage methodology attempts to answer three key questions: What species and communities occur in the state? How are they doing (status and trends)? Where are they found? A GIS-based data framework is used to store these data.

Natural Quality – Ecological Integrity

The key concept for evaluating natural communities is natural quality or ecological integrity. Ecological integrity refers to an ecosystem's wholeness - the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat [presettlement conditions] of the region. High-quality natural communities have good ecological integrity meaning they have the composition, structure, and functions as close to our concept of presettlement conditions. They represent portions of the landscape that have changed the least since the 1800s.

Natural quality or ecological integrity is intuitive to field biologists. Going from a parking lot to a corn field to an old-field and finally a high-quality tallgrass prairie one increases in ecological integrity. High-quality terrestrial natural communities have unplowed and uneroded soils, a high diversity and abundance of native plant (mainly perennial) and animal species, especially species

considered to be conservative or remnant dependent; a low abundance of exotic species, a mixture of vegetation structures, including old-age individuals (e.g., old-growth trees), and functioning or restorable natural disturbance regimes.

High-quality natural community sites have not been plowed, cleared, overgrazed, ditched, tiled, broadcast sprayed with pesticides, heavily logged, rutted, seeded or planted to exotic species, covered in excess sediments, leveed, and otherwise modified. On the flip side, fire suppression and flood control have negatively impacted many natural communities by cutting them off from vital natural disturbances.

"Grading" a Natural Community Site

The concept of grading natural quality originally evolved to describe the relative amount of change in a community due to direct, negative artificial disturbance by humans. The grading system provides terms for describing the relative amount of successional instability or change in a community's natural diversity, species composition, and structure due to negative disturbances (e.g., overgrazing, indiscriminant logging, bulldozing). The following general guidelines were used by the NFI to determine natural quality:

Grade A

Relatively stable or undisturbed communities - Ideally, a Grade A community has a structure and composition that has reached stability and does not show the effects of negative disturbance by humans. Note that some disturbances are positive for communities such as prescribed fire or flooding. Disturbances as used here are those that diminish the natural quality of a site. Grade A sites do include a range of conditions: the community may be gradually changing, or it may have been lightly disturbed. Examples: a prairie with undisturbed soil and natural plant species composition; a wetland with unpolluted water, unaltered water level, and natural vegetation; old-growth, ungrazed forest; or an ungrazed glade with few or no exotic plants, high diversity of conservative species, and minimal woody plant invasion.

Grade B

Late successional or lightly disturbed communities - A Grade B community is a former Grade A community that either (1) has recently been lightly disturbed, or (2) has been moderately to heavily disturbed in the past, but has recovered significantly. If the community was recently disturbed, it was not disturbed so heavily that the original structure and composition was destroyed. If the community was disturbed in the past, it has reverted so that it is reaching stability and is no longer rapidly changing. Examples: a prairie with somewhat weedy composition because of long-term annual haying management; a wetland in which original water levels have been altered which changed species composition locally, but did not destroy the structure and natural diversity of the community; or an old-growth forest with signs of light cutting or grazing.

Grade C

Mid-successional or moderately to heavily disturbed communities - A Grade C community either (1) has been moderately to heavily disturbed (and may or may not be reverting), or (2) has been severely disturbed and has reverted significantly. The disturbance to a Grade C community has been so great that the original structure was destroyed, and often the

composition has been changed significantly. This grade includes a broad range of degrees of disturbance and of recovery. Examples: a prairie that has been overgrazed so long that many native species have been replaced by weeds; a wetland with artificial water levels that has changed the structure and composition of the vegetation; moderately grazed or logged old-growth forest; young to mature second-growth forest; or a moderately diverse prairie or glade with heavy weedy or woody plant invasion.

Grade D

Early successional or severely disturbed communities - A Grade D community either (1) has been severely disturbed and has not recovered significantly, or (2) has been very severely disturbed but has begun to recover. A Grade D community has been so heavily disturbed that its structure (and usually composition) has been severely altered and is rapidly undergoing succession. (If the disturbance is constant, such as with continual grazing, the community may be stable - not succeeding.) Examples: a railroad prairie remnant with graded soil, dominated by weeds, with many native species missing; or a wetland that has been artificially flooded or drained, greatly changing the vegetation.

Grade E

Very early successional or very severely disturbed communities - A Grade E community has been so severely disturbed that the original community has been removed, and either (1) the site is going through the first stages of secondary succession, or (2) the natural biota is nearly gone. A Grade E community has very few or no higher plants or animals of the original community, and the land surface is often altered. Examples: newly cleared land, cropland, or improved pastureland.

Ranking of Terrestrial Natural Community Sites

When considering the ecological integrity of a natural community site we subjectively integrate three rank factors: condition, size, and landscape context to determine its rank as significant, exceptional or notable. Condition refers to the vegetation structure and composition, soil status, hydrological function, abundance of exotics, and the abundance of key plant and animal indicator species. Landscape Context refers to the degree of fragmentation of the habitat surrounding the site. Natural community ranks as described and defined by the NFI are listed below.

Significant natural community sites are important at the state-wide and ecoregional level:

- Area with Grade A or B natural community that equals or exceeds the minimum acreage (as defined for the region by the appropriate NFI report) for the type.
- Area with Grade A or B natural community that is smaller than the minimum acreage but that qualifies as the best example of a particular community.
- Area with Grade C natural community that qualifies as the only example.

Exceptional natural community sites are important at the regional and ecological subsection level:

- Grade A or B natural communities that are smaller than the minimum acreage, do not qualify as the only or best example, but are large enough to still be considered a stand (generally at least 5 acres for prairies).
- Grade C natural communities that qualify by exceeding the minimum acreage.

Notable natural community sites are important at the county level:

- Very small example of a Grade A or B natural community.
- Very large example of a Grade C natural community.

Inventory Methods

Information on natural communities is first compiled from existing sources, including the NHD, the scientific literature, museum collections, remote sensing data, detailed soils and geology maps, the U.S. Fish & Wildlife Service's National Wetlands Inventory maps, unpublished reports and the field experiences of biologists. Today the first best place to look is the Missouri Natural Heritage Database. Museum records have provided valuable leads to significant natural community sites in the past. For example, if looking for fens, a biologist might start by examining herbarium specimens from the Missouri Botanical Garden for certain fen restricted species and record locations where these specimens were found. The biologist would then review recent aerial photos of these sites, possibly doing an aerial fly-over of the sites, to determine which sites had the most promise to do a site visit to. The next step would be the field surveys to determine the actual extent, structure, and composition of the most promising fen sites. The final step is working up the field data and transferring these data to the NHD for any rare, threatened, or endangered species and high-quality natural community sites found.

The first step to an inventory is an office exercise and involves gathering all the data available for the site in question.

Step1 Compile existing information:

- The first step of the inventory process is to gather existing sources of data on the site. The best place to start is the NHD.
- Review the NHD for natural community and species of conservation concern element occurrences at the site in question.
- Find out whether the site contains a designated natural area.
- Ask area managers, MDC natural history biologists, fisheries biologists, resource scientists, and others knowledgeable about the site's natural features for information.
- Ask the MDC regional natural history biologist or natural areas coordinator if a natural history state lands inventory (SLI) has been conducted for the site and check the NFI for the site. Note that sometimes the information gathered by the NFI or the SLI did not make it into the NHD. So, if the NHD shows no records for a site you might want to consult the appropriate NFI or SLI report to double check for natural features.

Step 2 Identify potential natural features sites (PNFS):

- Assemble topographic maps for the site including overlays with NHD data.

- It is very helpful to compare current aerial photos to historic aerial photos to note the degree of changes in vegetation structure.
- After gathering information on the site in terms of topography, soils, landforms, existing and potential natural communities, actual and potential species of conservation concern, and land cover you're ready for identifying potential natural features sites to ground check. For example you might identify a PNFS that based on the background data compiled, you believe might have good quality dry-mesic sandstone/shale prairie on it. Map this area (PNFS) on a base map (topographic or aerial photo).

Step 3 Initial Ground Survey (IGS):

- Gather maps and field forms.
- Gather field gear: compass, GPS, clip board, pencils, binoculars, hand lens, camera, backpack, bug spray, sunscreen, water, and field guides.
- The purpose of the IGS is to verify that the natural community and or species of conservation concern site(s) actually exists.
- IGS can be done any time but preferably during the growing season.
- These are rapid, walk-through surveys.
- Finally the fun part. Now you get dirty and walk over the PNFS. Gather your maps and field gear and go out to the site.
- Note that during the NFI there was one more step before getting the boots on the ground. This was an aerial survey. For large sites and or sites with difficult access it can be very effective to schedule a fly-over of the site to check on the status of identified PNFS' and to locate possible new PNFS'. Of course given budget constraints this may not be an option.
- During the IGS the main purpose is to document whether the site is ecologically intact and what natural community types occur there.
- The field forms to use include the Natural Community Evaluation Form and the NHD Terrestrial Natural Community Reporting Form (attached). If the site contains natural communities or species of conservation concern already recorded in the NHD then bring print-outs of the NHD element occurrence records (including maps) with you to refer to and make notes on for providing updates back to the NHD.

Step 4 Final Field Survey (FFS):

- Revisit the site preferably 2-3 times during the growing season to get the full range of flora.
- Compile a site plant checklist.
- If time allows sample vegetation quantitatively using a macroplot or a transect with quadrats. Determine the floristic quality index for the site and or plots and importance values of vegetation (cover and frequency) in the plots.
- If time allows compare soils maps to field checks of soils using a soil probe or auger looking at textures, pH, mottling, and color by soil horizons.

Step 5 Mapping and Reporting:

- Map the natural communities on a 1:24,000 topographic base map and include species of conservation concern sites as well. Calculate acreages, grades, and ranks of natural communities.
- Provide summaries of the natural communities and rare, threatened, or endangered species populations.
- Complete NHD community or species reporting forms and provide these back to the Database.

NATURAL COMMUNITY EVALUATION FORM

Site Name: **Community Type:**

County: **Legal Location (TRS):**

Investigator(s): **Date:**

GENERAL DESCRIPTION:

DOMINANT PLANT SPECIES:

LISTED SPECIES:

COMMUNITY STRUCTURE/AGE (Applies mainly to wooded communities):

DIVERSITY/RICHNESS: High Medium Low

CONSERVATIVE SPECIES: High Medium Low
Comment/List:

NON-CONSERVATIVE SPECIES: High Medium Low
Comment/List:

EXOTIC/WOODY SPECIES ENCROACHMENT: High Medium Low
Comment/List:

OBVIOUS DISTURBANCES:

ASSOCIATED NATURAL COMMUNITIES/CONDITION:

PROTECTABILITY (Threats, associated features):

TERRESTRIAL NATURAL COMMUNITY REPORTING FORM

HERITAGE ECOLOGIST and LAB USE ONLY

EO_ID: _____ **SRANK:** _____ **GELCODE:** _____
ELCODE: _____ **EONUM:** _____ **Gelcode Confidence Level** (circle one): 1 2 3
Mapper: _____ **Map_QC:** _____ **Heritage Biologist:** _____
Tracker: _____ **Tracker_QC:** _____ **Date:** _____
Community Significance (circle one): Significant Exceptional Notable **Updater:** _____

ELEMENT IDENTIFICATION and LOCATION

EO Report Status (check one): New_____ Update **with** mapping_____ Update **without** mapping_____
Surveyor(s) (principal surveyor first; last name, first name):_____
Transcriber (if different than Surveyor): _____ **Transcriber Date**: _____
Natural Community Name: _____
Identification Problems (circle one): Y N **Explain**: _____
_____
Survey Site Name: _____
Directions to the survey site (include landmarks, roads, towns, distances, compass directions or GPS coordinates): _____
_____
County(ies): _____
USGS Quadrangle Name(s): _____
Twp:_____ **Rng**:_____ **Sec**:_____ **¼ Sec**:_____
Name of Managed Area(s): A)_____ B) _____ C)_____
Is EO completely within boundaries of Managed Area(s)? Yes or Partially (***Y* or *P***): A)_____ B)_____ C)_____
Owner(s): _____
Owner Comments :_____

MAP (Please attach a copy of a DOQ, aerial photo, or topographic map with site clearly marked)

Mapper (name of person who marked attached map): _____
Locational Uncertainty (How accurate is the mapped location of the actual location of the natural community?):
The mapped location is within (circle appropriate buffer radius in meters): 0 6.25 25 50 100 200 400 800 meters
OR, specify your own estimate: _____**m** or _____**ft** or _____**mi**

ELEMENT OCCURRENCE DATA

Survey Date (yyyy-mm-dd): _____
Plant species composition (EODATA) (Format: Year:Surveyor's Last Name – 5 to 10 dominant or characteristic plant taxa by scientific name): _____
_____
General Description (word picture of the natural community, including descriptions of topography and vegetation structure with different patches assigned acreage figures. For example, "a glade system with three openings of 1, 5 and 10 acres apiece." If this EO is mapped as part of a natural community complex, describe what percentage of the total polygon is made up of this natural community type. For example, "30% of a complex with wet-prairie and freshwater marsh."): _____
_____
_____
Natural Community Quality (EORANK) (Grade: A-D): _____ **Quality (EORANK) Comments** (Describe the natural community's ecological integrity; i.e., the degree to which it resembles presettlement condition, its lack of exotic species, the presence of conservative species, floristic quality index values, etc.): _____
_____
Geology (substrate): _____ **Acres**: _____
Management Comments: _____
_____
Protection Comments: _____
_____
Monitoring and Research Comments : _____
_____
General Comments: _____
_____
Reference (Best source for more information): _____

Thank you for your assistance in helping maintain the Missouri Natural Heritage Program.
Return to: Natural Areas Coordinator, Missouri Department of Conservation,
PO Box 180, Jefferson City, MO 65102
573-751-4115

10/24/96 ML&TN

MISSOURI NATURAL AREAS COMMITTEE

POST OFFICE BOX 180, JEFFERSON CITY, MO 65102

Missouri Department of Natural Resources

The Nature Conservancy
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